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EDITORIAL.

In view of the high cost of labour and the increased efficiency of agricultural machinery it is clear that the time has come when investigations into the use of the latter must be expedited. Government, in its policy of accelerating food production, is fully aware of the potential value of machinery for this purpose, as well as of the long-term advantages of mechanisation as a permanent feature in agriculture, and the Department of Agriculture has been instructed to investigate fully the possibilities of mechanisation in Malaya.

In this issue of the Journal, which is a special number confined to articles concerning mechanisation, the organisation which has been built up by the Department of Agriculture for investigations into mechanisation and some of the results obtained up to the end of 1947 are described. It will be seen that investigations into the mechanical cultivation of wet padi have been conducted with both medium and light machinery on different soil types in several States and Settlements, together with investigations into mechanical cultivation of dry padi. Much of the investigational work on dry land crops is being conducted at the Central Experiment Station, Serdang, and the costs of such operations, given in the article by Mr. Hartley, will be of interest to all planters.

Attention is drawn to an interim report on the mechanical cultivation of padi which forms an article by Mr. E. J. H. Berwick, an Agricultural Officer of the Department seconded for special duties in connexion with food production and mechanisation. It must be emphasised that the investigations so far conducted have been purely of an exploratory nature, and that although certain definite findings can be stated, the stage is far from being reached where recommendations for the commercial development of mechanisation can be made.

An article by Mr. Egan of the Drainage and Irrigation Department indicates that for building bunds in certain circumstances a bulldozer will operate at costs comparable with those of the dragline excavator, the machine normally used by his Department.

It is important that, if mechanisation has come to stay in Malayan agriculture, instruction should be given to our future agronomists at an early age. It has been found possible, even with the meagre number of implements available to the Department at the present time, to allocate some

to the College of Agriculture, Malaya, Serdang, in order that students may become familiar with them, and an article by the Principal of the College gives an indication of some of the work being done there.

Selected articles on the subject of mechanisation, which, it is considered, will be of interest to the general public, are also included in this special number, together with reviews of the more important agricultural engineering journals.

Original Articles.

THE STANDING COMMITTEE ON CROP INVESTIGATIONS WITH SPECIAL REFERENCE TO INVESTIGATIONS INTO MECHANISATION

BY

A. E. S. McINTOSH,

Deputy Director of Agriculture,

Chairman, Standing Committee on Crop Investigations.

Introduction.

The Standing Committee on Crop Investigations was appointed by the Director of Agriculture as a permanent Committee of the Department under the chairmanship of the Deputy Director of Agriculture. It comprises in its membership the following senior officers representing the Department Administration and the Research and Field Branches: Deputy Director of Agriculture, *Chairman*, Chief Research Officer, Chief Field Officer, Senior Agricultural Officer (Research), State Agricultural Officer, Selangor, Agricultural Officer i/c Central Experiment Station, Serdang, Agricultural Economist, *Secretary*.

The functions of this Committee are to make recommendations to the Director with regard to all experimental work and to ensure its co-ordination. The representative nature of the personnel on the Committee is such that it includes officers from all Branches concerned and is calculated to ensure co-ordination of the work within the Department throughout Malaya.

Investigations into Mechanisation of Agriculture.

(a) GOVERNMENT POLICY.

The Government of the Malayan Union realises the possible advantages to be derived from the introduction of mechanisation into agriculture. In connexion with the production of existing crops, difficulties are being experienced with labour in the form of shortages, high costs and inefficiency to perform certain agricultural operations. At the same time, it is Government's policy to encourage agricultural extension aiming at a greater acreage of both cash and foodcrops (especially wet padi), the latter with a view to approaching some measure of self-sufficiency in foodstuffs. Any such extension may be hampered by labour shortage and will further result in accentuating labour difficulties. These considerations have led the Government seriously to consider in how far the apparent usefulness in Malaya of mechanisation in agriculture could in fact be implemented in practice on an economic footing. Clearly, any appreciable rational development of mechanisation on a commercial scale would in the first place require

and be dependent upon the results of precise and comprehensive investigational work designed to indicate if and where mechanisation is both feasible and economic. The Government has, therefore, called upon the Department of Agriculture to undertake appropriate investigations.

(b) A Broad Classification of Conditions in Malaya as they might affect the approach to Investigations on Mechanisation.

The Standing Committee on Crop Investigations to which, in keeping with its terms of reference, such mechanisation investigations have been referred by the Director of Agriculture, has in the short time at its disposal considered the broad lines upon which schemes for investigations should be based, with a view to making recommendations for choosing and siting investigations, deciding on the operations to be mechanised and the nature of such and so the amount and kinds of machinery which may be imported for the purpose.

Broadly, agriculture in Malaya, from the point of view of mechanisation may be divided into two classes, i.e. (i) agriculture on the wet padi or *sawah* areas and (ii) agriculture pursued under dry-land conditions.

For each of these well defined classes the choice of machinery is determined by (1) their conditions and (2) the operations considered best suited to giving optimum agricultural results.

(c) The Conditions as they might affect Choice of Machinery.

With regard to the first of these two classes, (i.e. the *sawahs*) consideration is being given to the factors which may affect a choice of type of machinery likely to succeed. Clearly, the important factors are those which affect the physical ability of the land in question to support machinery. This is largely referable to the seasonal incidence of water on the land, and this, in turn, is referable to (a) rainfall (b) presence or absence of organised drainage and irrigation facilities, and the degree of effectiveness and control where irrigation exists, (c) site and topography and (d) nature of the soils. These factors quite obviously interact one with the other, and individually and collectively influence in a greater or lesser degree decisions on considered machinery requirements. The Committee is classifying *sawah* areas on such *a priori* considerations for purposes of assessing machinery requirements for each category of the class. It should at this point be emphasised how unique and novel these conditions are for mechanisation, and a consideration of them calls for evolving appropriate modifications of existing standard dry-land machines or altering the conditions and/or timing the operations to suit dry-land machinery. In general, the conditions call for decreasing the weight of the machinery units on the land and yet at the same time increasing the grip of their propelling parts—the wheels or tracks. The first may be achieved by increasing the surface area of the propelling parts, so that the weight per unit area on the land is less, while the second may be assisted by anti-

skid devices. At the same time the degree of grip required for propulsion may be made less by, wherever possible, employing units where power drive of the propelling parts is separate from any other power drive required within the unit. Actual anti-sinking devices (e.g., of the weasel type) may have usefulness.

With regard to schemes for investigation in mechanisation of agriculture under dry-land conditions, it is emphasised that, in keeping with the climate and soils of Malaya which favour a tropical forest growth, tree crops are in the main most suited economically to these conditions. The principal dry-land crops are rubber, coconut, oil palm and miscellaneous fruit trees. At the same time, however, shrubby economic crops such as tea, pineapples, tapioca, derris and bananas are also grown under dry land conditions, and finally herbaceous annuals such as tobacco, sweet potatoes, dry padi, groundnuts, maize, soya bean and green vegetables (the last-named in market gardens).

The Committee is considering schemes for mechanisation investigations under these crop-type heads. In addition, however, and of greater importance is the nature of the soils on which such crops are grown, and it is of interest to record that in general in Malaya soil-type so far has had in commercial plantings little influence in affecting the distribution of these crops. (This aspect will be a subject of separate enquiry).

Mechanisation investigations on dry-land are therefore being approached on a classification based on crop-type and more especially soil-type. With regard to the latter, it is clear that the types of machinery required would vary greatly between the major soil-types such as coastal clays, organic soils (peats) and sands and admixtures of these in the coastal alluvial series, and inland quartzite soils, granite soils and the river alluviums. Machinery requirements for dry-land in Malaya as a whole are essentially similar to those for dry-land agriculture elsewhere and choice for the varying conditions within the class (dry-land) is largely referable to the operations considered most suitable for the soil-type and crop-type. The special difficulties anticipated for machinery for *sawah* operations are not expected for dry-land conditions.

At the same time, details of the labour requirements for the various existing phases of wet padi and dry-land crop growing are being collected and summarised, for it is clear that, other things being equal, priority in mechanisation investigations with a view to commercial application should be given to those operations which under the existing methods of hand cultivation require the greatest amount of labour.

(d) The Possible Operations as they might affect Choice of Machinery.

The Standing Committee is considering separately the operations which might prove to be best suited to giving the best agricultural results for each of the well-defined classes, that is, (i) *sawah* areas and (ii) dry-

land areas. At the same time, similar considerations are being given to the most suitable operations in recognisable categories of each of these main classes.

With regard to the *sawah* areas in Malaya, the soil-type, the seasonal incidence of water and the rate of movement of water are very variable between the various areas. Much has been written on the best cultivation methods for wet padi production, but in general it is safe to state that every effort should be made to control weeds and to induce a free flow of water at all times during the growing season. It is clear that the type of machinery required for optimum operations should be such that, by its use and wherever possible by the correct timing of its use, these two salient factors are rendered as effective as possible. It should not be forgotten that wherever water control is possible—and this would appear to be desirable always—dry conditions could be provided in which operations for both the suppression of weeds and the optimum flow of water through the soil could be vastly assisted. At the same time, any adequate water control would physically facilitate mechanisation and indeed, in so far as mechanisation is concerned, would render the operations required for wet padi growing fundamentally the same as those for dry-land crops. Conditions such as these are present in the rice-growing areas of New South Wales and California. Unfortunately, and in general, such an ideal state of affairs, even where water control is possible, is not altogether present in Malaya. The site and topography of many areas and the uncertainty of distribution of the rainfall are such that water control is impracticable and land preparation for the wet padi crop requires to be carried out in many cases under conditions even of surface water. In such areas, however, mechanisation of tillage operations, resulting in their being done in a very much shorter period than those by hand, might allow of cultivation being carried out in the comparatively short duration of relatively dry conditions. This is at least an approach to the ideal. There is every evidence to indicate that thorough cultivation during the off-season with consequent aeration and creation of soil conditions better suited to a free flow of water is very favourable to subsequent crop growth. Moreover, it is during the off-season that *sawah* conditions are relatively drier.

Mechanisation of wet padi growing is largely referable to tillage, control of weeds and harvesting. Tillage will aim largely at providing a free flow of water and control of weeds, while harvesting is essentially an unrelated operation. A free flow of water is favoured by rendering the soil open to a practicable depth. Control of weeds should be achieved prior to the planting of the crop, by the turning up and exposure of roots in drier conditions and by deep burying in wetter conditions. Indications are that this may be achieved by early tillage following harvesting of the previous crop with perhaps, suppression of weed re-growth by the rapid establishment of a smothering annual crop, chosen for its qualities of rapid establishment, 'blanket'-like growth and value as a green manure, e.g., an annual legume.

Weeding the standing padi crop by means of machinery cannot be viewed as a practical proposition; hence weed suppression should be effected during the off-season to a degree that the subsequent padi crop may get ahead and, together with the " drowning " effect on the weed flora of the water on the padi, suppress any attempt by weeds to grow sufficiently to have a deleterious effect on the padi.

Operations of deep ploughing by mould-board and disc ploughs and, even in some cases chiselling, are suggested for the creation of a good tilth and the suppression of weeds. In peaty and light soils, weed suppression dictates the operations; in clayey soils the creation of a tilth is also important. In the latter soils, additional operations of rolling and harrowing will require investigation.

When conditions permit, drill sowing or broadcasting by machinery will be tried; where this is impossible, the use of up-to-date machines for transplanting nursery-raised seedlings will be tested.

For harvesting, for full use of up-to-date harvesting machinery, conditions of firmness of the land will be required, but, depending on the degree of this and the magnitude of the unit areas to be harvested, ranges of harvesting machinery types will be tried from the lightest hand-guided power-driven simple cutters, through power-drawn reapers, to binders and combine harvesters, the last to mechanise threshing operations. Where harvesting cannot be done by machines designed to include threshing, tests of independent and stationary threshing machines will be tried, the cut padi being gathered and brought to the threshing machines by mechanical means.

With regard to considerations of operations required for dry land agriculture, these are, as has been indicated in section (c), dictated by (i) crop-type and (ii) soil-type.

With regard to crop-type as affecting the operations, it is considered that the optimum land treatment by machinery for land preparation is common to all crop-types, and this, in turn, will be considered under the effect of soil-type on land preparation operations. Between the crop-types, however, there will inevitably be differences in certain operations chiefly referable to mechanisation operations concerned with after-cultivation and harvesting. With regard to tree crops, e.g., rubber, coconut and oil palm, mechanisation of after-cultivation operations such as establishment and cutting of ground covers, mulching, manuring and, wherever considered feasible, harvesting operations, is being kept in mind. With regard to shrubby economic crops, special attention will be paid to the possibility of mechanical harvesting of both tapioca and derris roots. With reference to the herbaceous annuals, mechanisation operations aiming at soil conservation and maintenance of fertility and suppression of weeds will be closely watched. Mechanical sowing or planting, manuring and harvesting of " root " crops like sweet potatoes and groundnuts and grain crops such as maize and soya bean will be items for attention.

Mechanisation operations under dry-land conditions for land preparation are common to all dry-land crops, and are dictated largely by soil-types. The salient soil-types have already been mentioned in the last paragraph of section (c) and in considering the operations for these soil-types, a convenient classification may be made as follows:—

(i) Coastal clays
(ii) Peats
(iii) Sandy soils, inland quartzite soils, granite and river valley alluviums.

The clays are, geologically speaking, a recent deposit between inland quartzite undulating soils and the coast. On the western side of the Peninsula, they form a belt of appreciable width and are, if anything, on the whole heavier than the narrower clay belt on the eastern side of the Peninsula. By their situation and topography and their texture, they tend to be water-logged and serious agricultural results have followed the inevitably indifferent cultivation of these intractable soils under conditions of hand labour. Operations of preparatory tillage, drainage and maintenance of drains by mechanisation under these conditions have great possibilities and will be aimed quite obviously at improving their water relationship, so that rainwater percolates into and moves freely through them. This will result in an increase in their effective depth from the plant root-growth point of view. Operations here will be tested on lines similar to those now carried out in commercial practice for heavy clay soils in the sugar-cane areas of the British West Indies. Provision of drains and cambered beds by means of machinery will be tried and the fracture of the clay in beds when dry by chiselling. Further mechanisation operations will be directed towards providing a surface cover either from the establishment, growing and cutting of "cut and come again" herbaceous perennials, or by mulching with the existing crop residues or by the transport of mulching material from elsewhere.

With reference to the peat, great importance will be paid to its conservation by maintaining the water table at a level which will both admit of reasonable penetration of crop root growth and at the same time avoid any shrinkage of the peat which leads to root disturbance, and worse still, to a quick oxidation of the peat itself and consequent loss. At present, it appears that there is little or no need for preparatory tillage for this peat soil, and any mechanisation operations would rather be directed towards the control of weeds, sowing or planting and harvesting.

With reference to the lighter soils mentioned in the last category above, these are in the main naturally free-draining, and soil moisture conservation and increase of humic matter form predominant problems. Mechanisation operations would, therefore, be designed to achieve these ends by the use of machinery for contour bunding, contour terracing, and the provision, transport and spreading of mulches to avoid erosion water loss through

surface evaporation and to increase the humic content of the soil. In some cases, 'pans' occurring at varying depth and of different natures occur in these soils, and these have the deleterious effects, if near the surface, of rendering difficult penetration of rainwater and crop-roots and, especially on sloping land, of favouring sheet and gully erosion. Some form of chiselling would here appear to be desirable.

Conclusion.

In the light of the considerations set out in this article, a comprehensive range of agricultural machinery is to be acquired. This is detailed in the following article in this number of the Journal.

THE ORGANISATION FOR THE COLLECTION AND MAINTENANCE OF AGRICULTURAL MACHINERY

BY

A. E. S. McINTOSH,

Deputy Director of Agriculture,

AND

E. J. H. BERWICK,

Agricultural Officer, Food Production.

Introduction.

In the previous article it has been indicated how the choice of machinery is being guided by a classification of agricultural conditions and the operations which are likely to be successful in each.

In a selection of numbers and kinds of machines for conditions and operations of such novel and diverse natures, decisions must be to a certain extent speculative, and it is thus necessary, within broad types of power machines and implements, to acquire a range of kinds and makes. Whereas a consideration of the conditions and operations to be performed may suggest general machinery requirements for each category it is desirable to acquire a wide range within each to allow of investigations revealing the most suited for eventual recommendation for commercial usage. Accordingly, the principle of selection in the first place is to acquire all the variables and one or at most a few only of each. In all cases, and for purposes of ensuring continuity in the work, adequate spare parts are being acquired, and, where desirable for purposes of tests, certain accessories.

Collection of Machinery.

In these days of machinery shortage, the matter of its acquisition is not an easy one. During 1946, the Government acquired both from the British Army in Malaya and the United States military authorities in the Philippines an appreciable number of power units of restricted range in type and a very small number of implements. Unfortunately the power units were of the heavy and medium type only and not adapted to many of the conditions likely to be best suited by the use of light machinery. This has resulted in a position where in many cases power machines of certain types are surplus to investigational requirements while implements are very much in short supply.

The acquired machines from these above-mentioned sources represent only a very small part of the total requirements. Steps were therefore taken to import machinery from such principal sources as the United Kingdom,

Australia and the U.S.A. In spite of the greatest official support and the competitive interests of commercial firms in acquiring machinery, orders have been and are still very slow in being fulfilled. In this unfortunate aspect, Malaya is not singular, and until such time as world requirements for agricultural machinery become easier to satisfy, this state of affairs will continue. Under the circumstances, therefore, earlier investigations must of necessity be short of the ideal, and attempts are being made at improvising any investigation with the restricted range of available machinery. To ease the position consequent on shortages, an organisation has been set up which allows for a rapid distribution to, and between sites of, investigation.

Kinds of Machinery.

The kinds of machinery, the numbers desired and the numbers actually in possession together with the conditions and operations for which it is proposed to use each are given in Table I. The machinery is classified on a basis of weight, power units or implements, the kinds of such and finally the actual makes (the last being omitted from the Table). The heavy types of power units and implements are intended mainly for use for jungle clearance, for new planting and clearance of old rubber, coconut and oil palm, for replanting, and for operations associated with drainage. At the same time, it is anticipated that such machinery may be desirable for tillage operations under the dry-land conditions of the coastal clays where heavy machinery may be the most effective in ameliorating the water relationship conditions of the existing impervious clays.

The medium type of power units and implements will be investigated over a wide range of conditions and in a comprehensive series of operations as described in the previous article. Indeed, it is likely that the general use of medium weight machinery will be precluded only where agricultural unit areas are not large enough to bear the initial costs of such machines, in which cases light machinery will probably be preferable.

It is anticipated that light machinery will have a wide usefulness in Malaya, particularly among the smaller units of small-holders both under *sawah* and dry-land conditions. It is not expected that such machinery will be able to effect adequate tillage in heavy coastal clays, but otherwise it is felt that it will be suited to operations for most other conditions in small agricultural units. A wide range of such machines will therefore be acquired for test.

Referring again to Table I and to the columns 'Number Required' and 'Number in Stock', the former column indicates the numbers considered necessary for a full investigation programme, while the latter column shows to what extent these have so far been obtained. The discrepancy between these two columns shows the difficulties being experienced in getting the desired machinery.

The remarks under the columns 'Conditions' and 'Operations' serve to link up the details of the machinery with the conditions and operations

TABLE I.

PROPOSED MACHINERY FOR INVESTIGATIONS.

I. Machinery Decentralised to Federal Experiment Stations.

Machinery	No. Required	No. in Stock	Conditions	Operations
A. Heavy	—	—	—	—
B. Medium I. Power				
(a) Crawler Tractors ..			—	—
(b) Wheeled Tractors				
(1) Fordson Standard ..	15	9	General	Haulage & stationary power
(2) Fordson Row crop ..	3	3	General, esp. dry land	-do-
II. Implements				
(a) Clearing and Draining ..		—	—	—
(b) Tillage ..				
(1) Mounted Mould-Board Ploughs	9	—	General, esp. *sawah* and hilly land	Ploughing for thorough cover of shorter vegetation
(2) Trailer Mould-Board Ploughs	9	5	General	-do-
(3) Mounted Disc Ploughs ..	9	—	General, esp. *sawah* and hilly land	Rough ploughing and turning in rank vegetation, contour bunding
(4) Trailer Disc Ploughs ..	9	5	General	-do-
(5) Mounted Disc Harrows ..	18	—	General, esp. *sawah* and hilly land	Light tillage, preparation of seed bed, weeding
(6) Trailer Disc Harrows ..	18	9	General	-do-
(7) Mounted Cultivators ..	9	—	General, esp. *sawah* and hilly land	-do- and inter-row cultivation on dry land
(8) Trailer ..	9	5	General	-do-
(c) Planting and Sowing				
(1) Disc Drills ..	7	5	General	Sowing
(d) After-cultivation				
(1) Covering Harrows ..	7	5	General	Covering Seed
(e) Manuring ..	—	—	—	—
(f) Pest and Disease Control ..	—	—	—	—

	Machinery		No. Required	No. in Stock	Conditions	Operations
	(g) Harvesting					
	(1) Mounted Cutterbars	..	5	—	General, esp. *sawah* and hilly land	Reaping grain crops, cutting cover crops, haulms and vines
	(2) Trailer Cutterbars	..	2	—	General	-do-
	(3) Forward Mounted Rakes	..	4	—	General	Collecting and transporting all forms of vegetation
	(4) Threshers	..	5	5	General	Stationary threshing of seed bearing crops
C. Light	I. Integral					
	(a) Normal type	..				
	(b) Rotary type	..	18	5	General	Tillage, incorporation of light vegetation, preparation of seed bed and weed control in small agricultural units.
	(c) Miscellaneous					
	(1) Cutterbars	..	7	1	General	Reaping of grain crops, cutting cover crops, haulers and vines.
	II. Non-Integral					
	(a) Normal type	..	18	—	General	Tillage, incorporation of light vegetation, preparation of seed bed and weed control in small agricultural units
	(b) Rotary type	..	2	—	General	-do-
	(c) Miscellaneous	..			—	—

TABLE I (contd.).

II. Machinery Centralised in the " Pool."

	Machinery	No. Required	No. in Stock	Conditions	Operations
A. Heavy	**I. Power**				
	(a) Crawler Tractors				
	(1) D8	4	4	Dry land	Power for heavy duty
	(2) D7	2	2	-do-	-do-
	(3) HD 10	3	3	-do-	-do-
	(4) TD 9	2	1	General	-do-
	(5) D4	10	10	-do-	-do-
	(b) Wheeled Tractors	—	—	—	—
	II. Implements				
	(a) Clearing and Draining				
	(1) Stumpers	1	1	General	Clearing (including stumping and levelling) jungle and old rubber, oil palm and coconut plantings for new and re-planting
	(2) Bulldozers	4	4		
	(3) Cranes	2	1		
	(4) Forward Winches	3	3		
	(5) Rear Winches	4	4		
	(6) Root Rakes	2	1		
	(7) Ditchers	5	—	General, esp. coastal clay and peat soils	Planned drainage
	(b) Tillage				
	(1) Chisels	5	—	General, esp. coastal clays	Amelioration of soil water relationships and increasing effective soil depth
	(2) Mould-Board Ploughs	4	—	General	Heavy duty tillage
	(3) Disc Ploughs	4	—	-do-	-do-
	(4) Disc Harrows	3	3	-do-	Heavy duty tillage, preparation of seed bed and weeding.
B. Medium	**I. Power**				
	(a) Crawler Tractors				
	(1) TD 6	1	—	General, esp. *sawah*	Power for haulage and stationary work
	(2) D 2	1	—		
	(3) Bristol	2	—	General, esp. hilly land	

	Machinery	No. Required	No. in Stock	Conditions	Operations
	(b) Wheeled Tractors				
	(1) Fordson Standard ..	4	4		
	(2) Fordson Row Crop ..	2	2		
	(3) Field Marshall ..	1	—	General	Power for haulage and stationary work
	(4) Ferguson ..	2	—		
	(5) Farmall A. ..	2	2		
	(6) Farmall H. ..	2	—		
B. Medium II.	Implements				
	(a) Clearing and Draining				
	(1) Earth movers ..	1	—	General	Clearing (including stumping and levelling) jungle and old rubber, oil palm and coconut plantings for new and re-planting
	(2) Winches ..	2	—		
	(3) Land levellers ..	1	—	General, esp. coastal clay and hilly lands	For grading beds in coastal clays, contour terracing on inland quartzites
	(4) Terracers ..	2	—		
	(5) Ditchers ..	1	—	General, esp. coastal clay and peats.	Planned drainage
	(6) Mole Ploughs ..	2	2	Coastal clays	Mole drainage
	(b) Tillage				
	(9) Chisels ..	1	—	General, esp. coastal clays	Amelioration of soil water relationship and increasing effective soil depth
	(10) Reversible Mould-Board Ploughs	1	—	Hilly land and *sawahs*	Tillage
	(11) Reversible Disc Ploughs ..	2	—	do-	-do-
	(12) Prairie Busters ..	1	1	Coastal clays and river alluviums	Deep tillage
	(13) Rotary Cultivators ..	6	1	General, esp. *sawahs*	Tillage, preparation of seed bed and incorporation of lighter vegetation
	(14) Ridgers ..	1	—	General	Ridging for dry land root crops and for off-season crops in *sawahs*
	(15) Muddle Busters ..	1	—		
	(c) Planting and Sowing				
	(2) Augurs ..	1	1	Dry land	Tree-crop planting and fencing
	(3) Transplanters ..	2	—	General, esp. *sawah*	Transplanting seedlings of all crop types

	Machinery	No. Required	No. in Stock	Conditions	Operations
	(d) After-cultivation				
	(2) Plough Packers ..	2	—	General	Preparation of fine tilth and seed bed
	(3) Cambridge Rolls ..	3			
	(4) Spring tyne Harrows ..	4	2		
	(e) Manuring ..				
	(1) Manure loaders ..	1	—	General	Transport and application of organic manures and mulches and manure loader to assist in preparation of compost
	(2) Manure spreaders ..	1	—		
	(f) Pests and Disease Control ..	—	—		
	(g) Harvesting				
	(5) Hay Rakes ..	1	—	General, esp. *sawahs*	Harvesting seed crops
	(6) Side delivery Rakes ..	1	—		
	(7) Reaper Binders ..	1	—		
	(8) Combined Harvesters ..	2	—		
	(9) Potato lifters ..	1	—	Dry land	Harvesting of root crops
	(10) Hullers ..	4	4	General	Hulling maize
	(h) Miscellaneous				
	(1) Trailer wagons ..	2	—	General	Field transport
C. Light	I. Integral				
	(a) Normal type ..				
	(b) Rotary type ..				
	(c) Miscellaneous				
	(2) Mechanical saws ..	8	8	General	In connection with clearing jungle
	(3) Mechanical pump ..	4	4	*Sawah*	Water control in small units
	(4) Fire Guns ..	2	2	Dry land	Weed and pest control and soil sterilization
	II. Non-integral				
	(a) Normal type ..				
	(b) Rotary type ..				
	(c) Miscellaneous				
	(1) Cutterbars ..	2	—	General	Reaping of grain crops, cutting cover crops, haulms and vines

described in the previous article and, as it were, provide the reason for acquiring in each case the machines noted.

Organisation for Receipt and Preliminary Testing of Machinery.

The Central Experiment Station, Serdang, provides the most suitable site for the initial collection, housing and preliminary testing of imported machinery. The Serdang Station extends to some 600 cultivated acres with a large variety of crops including economic tree crops, shrubby crops and annuals. Moreover, the Station is situated near Headquarters, is well-staffed and has adequate buildings.

Machinery when received is despatched to Serdang, where preliminary tests are made with a view to assessing performances in general and to acquainting operators and machines with the machines.

Distribution of Investigations.

Sites for investigations at present exist or will be opened up at points representative of the conditions under which it is proposed to test machinery. These sites are or will be chosen to cover the range of conditions detailed in the first article. They will be in the form of both Federal Experiment Stations (designed solely for investigational work) and State/Settlement Extension Stations run by the Department of Agriculture.

Distribution of Machinery.

The bulk of the machinery will be distributed to the Federal Experiment Stations where it will be used on investigational work, selection for distribution being in general guided by the conditions and intended operations at each Station. The machines allocated to any Station will be retained until such time as investigations reveal their value. On a basis of such assessed values, further machinery of proved worth will be acquired and distributed to State/Settlement Extension Stations for purposes of routine operations and demonstration.

The highly specialised machinery will be centred on Serdang and will be distributed only to appropriate sites for investigation, on the completion of which, such machinery will be returned to Serdang. This class of machinery constitutes as it were a central " Pool."

Training Personnel.

In a country unaccustomed to the use of agricultural machinery, an adequate training of personnel such as operators and mechanics will be essential for investigational work in the first place and subsequently for an effective extension of successes. It is, therefore, proposed, concurrent with the acquisition and testing of machinery, to train such personnel, and the Central Experiment Station at Serdang, constituting as noted above the site for receiving machinery and for the " Pool " and further, being adjacent as it is to the College of Agriculture, Malaya, suggests itself as the most appropriate site for this purpose. An organisation is being developed to train operators and mechanics in the actual working and maintenance of machinery, the trainees being drawn from the agricultural students at the College and prospective operators and mechanics for Government and commercial employment.

INTERIM REPORT ON EXPLORATORY INVESTIGATIONS INTO THE MECHANICAL CULTIVATION OF PADI

BY

E. J. H. BERWICK,

Agricultural Officer, Food Production.

Introduction.

For an *immediate* increase in production of home-grown padi to meet shortfall in imports, little can be expected from mechanical cultivation, inasmuch as little or nothing is known of mechanisation of padi production either in Malaya or in countries where conditions are approximately similar, nor is machinery available in commercial quantities. Granting a long term policy aiming at greater self-sufficiency in the staple foodstuff, rice, and an increasing population in Malaya, with increased requirements of rice greater than its own labour is likely to produce by hand means, it is clear that mechanisation of padi production is an essential.

In an approach to considerations for mechanisation of padi growing, the first steps to be taken were to make a broad survey of the conditions in which padi is cultivated in Malaya, based on possible requirements associated with mechanisation; the next stage was to review the literature concerning the mechanisation of wet padi in general in other countries and, in particular, to investigate any adaptations in agricultural machinery which had taken place recently in countries whose problems were likely to be comparable with those of Malaya. With such information, appropriate lines of work were considered, but these could not be put into operation *in toto* chiefly in view of a lack of trained staff and equipment. As these shortages are made good by training and importation respectively, the work will expand to meet the full requirements of comprehensive investigations.

To avoid delay and to effect some exploratory work, an improvised programme for investigations into both wet and dry padi cultivation was prepared, making full use of the staff and machinery available. Investigations were in the first place, for the sake of transport facilities, confined to the Settlement of Penang and Province Wellesley, and the States of Perak and Selangor, but later when preliminary work done in these States had shown signs of promise, some tractors and implements were sent to Pahang Tua in the State of Pahang for trials on a larger scale under conditions of controlled irrigation, and at the same time to serve to encourage padi growing by the people in an area in which morale was low owing to prevalence of disease. The details of these investigations are given in the articles which follow while overall conclusions and deductions are discussed below in summary form.

The Machinery and Operations Tested.

Wet Padi Areas.

A. Heavy Equipment.

(a) Clearing. It has been shown that on peat soils, for the purpose of removing stumps, equipment of weight up to 6 tons can be operated on an apron of steel and timber. From this it would appear that, provided water conditions can be controlled, there seems to be no reason why similar methods should not be effective for the clearing of jungle. A considerable amount of investigation will however be required to ascertain if such methods are economic and their economics relative to other methods of clearance such as the use of explosives and poisoning. On coastal clays the problem of clearing jungle should be easier but trials have not yet been conducted.

(b) Tillage and Sowing. It has been shown that both on peat soils and on coastal clays in a wet condition heavy disc-harrows, which were the only heavy implements available, tended to sink into the soil and were of little value. Heavy tractors (D.4) were, at times, employed for drawing medium implements, but in these cases they were used as examples of track-laying tractors of which no medium-weight specimens were obtainable; they will therefore be discussed under medium equipment.

B. Medium Equipment.

(a) Clearing. It is possible that clearing and stumping may be more economically performed, at any rate on peat soils, by lighter equipment which was unavailable this year.

(b) Tillage. On peat soils such as those at Sungei Manik in the State of Perak, it seems clear that any tractor which has a bearing pressure of more than 3 lbs. per sq. in. will be valueless and this rules out wheeled tractors with standard equipment. Track tractors with wooden extension shoes have been proved to be successful and wide gauge models of such types as D. 2 and TD. 6, with swamp shoes and extensions if necessary, should prove a commercial proposition. On these soils cultivation with disc-ploughs or disc-harrows is all that is necessary. On coastal clays it has been shown that with standard equipment it is possible to cultivate either in dry or in wet conditions; difficulty is likely to be encountered, however, if cultivation is attempted when the water-content of the soil approaches the 'sticky point.' As regards the power unit, track tractors appear to be unnecessary, and, in view of their higher maintenance costs, undesirable; steel wheel tractors of the standard type have been satisfactory, and, contrary to experience in Ceylon, rubber tyres appear to be useless. Mould-board ploughs do well on grazed areas but where there is a full growth of off-season weeds disc-ploughs are more satisfactory. Disc-harrows of medium weight, especially of the ' cut-away ' type do well, and experience with rotary cultivators of horticultural types shows that this method of cultivation may be valuable.

(c) Sowing. It has been shown that sowing by means of a drill is possible even on peat soils, but the whole question of the efficacy of sowing vis-a-vis transplanting is related to efficient weed-control, and this matter will possibly require several seasons to investigate.

C. Light Equipment.

Most of the horticultural tractors ordered arrived too late to be tested satisfactorily for the 1947-48 season. It appears clear that with these light tractors, elimination of skid is going to be one of the main factors; rubber tyres are useless and the steel wheels will have to be considerably wider and with longer spuds than standard types. Rotary hoes working in 2 to 3 ins. of water have shown that they are capable of producing a soil tilth into which seedlings may be successfully directly transplanted. Considerable modifications will, however, be necessary before this type of machine can be used commercially.

Dry-land Areas.

A. Heavy Equipment.

(a) Clearing. Bulldozers have been used successfully for removal of both rubber trees and rubber stumps but it is likely that in the former case the trees can be more economically felled by means of a steel wire drawn between two tractors. In all cases, however, deep craters are left, which, in the process of levelling, fill in with top soil thus leaving the field sporadically denuded of top soil and exposing infertile sub-soil; in the peats and deeper coastal clays, however, the consequent deleterious effects are not so marked as in the inland quartzite soils.

(b) Tillage. Heavy disc-harrows, the only heavy equipment available, did well when pulled by a 35 h.p. track-tractor and it is probable that other heavy implements such as 8 to 10 furrow disc-ploughs and multiple disc-harrows would work economically.

B. Medium Equipment.

(a) Tillage. It was found that on quartzite soils, steel-wheeled tractors were more satisfactory than those with rubber tyres which tended to skid on turning. Track-tractors are good but visibility is poor and makes intricate operations difficult. Disc-ploughs and harrows work satisfactorily, cut-away disc-harrows probably being preferable to the normal ones for turning in crops. A compacted seed-bed is essential for dry padi and so rolling or straight-tyned harrowing may be necessary.

(b) Sowing. Disc-drills were used satisfactorily.

(c) After-cultivation. Weeding of the growing crop with the available implements was difficult but with a forward mounted tool bar would probably cause little trouble.

C. Light Equipment.

No tractors of the horticultural type were available for test on dry-land.

Costs.

It must be realised that, in the present exploratory stage of investigations in Malaya, it is impossible to give accurate costs of mechanical cultivation, but it is felt that growers will be interested to have approximate figures. Even when figures based on a large number of working hours are available, the method of calculating the costs is highly controversial but that given below is probably as useful a method as any, at any rate in preliminary investigations.

In the articles in this issue, running costs, which include only the expenditure on fuel and lubricants, and on wages paid to operators and such labour as is required to assist in the operation, are given. In all cases these have been reduced to a standard level, which is the rates of wages and prices ruling on the 1st December, 1947, as follows:—

Petrol	$1.40	per gallon.
Kerosene	0.87	„ „
Diesel Oil	0.47	„ „
Lubricants	3.00	„ „
Operators, Class I—Standard Rate $3.00 per day plus $1.12 C.O.L.A.* = $4.12 per day	0.63	per hour.
Operators, Class II—$2.60 per day plus $1.04 C.O.L.A. = $3.64 per day	0.56	„ „
Motor Cultivator Drivers—$1.12 per day plus $0.72 C.O.L.A. = $1.84 per day	0.28	„ „
Labourers, Unclassified—$0.96 per day plus $0.68 C.O.L.A. = $1.64 per day	0.25	„ „

The wages of operators have been calculated on a working day of 6½ hours, that is to say, the tractors work for 6½ hours and the operators are allowed half an hour in the middle of the day for a meal and half an hour to clean and carry out daily maintenance to their tractors and implements at the end of the day.

In addition to the running costs, there are, however, many other items of expenditure, generally known as overhead costs, which must be debited to the operation. The main ones are depreciation of and repairs to the tractor and implement, but to this should be added a charge for housing, insurance and interest on the capital expended.

Depreciation will obviously depend on the number of days' service a tractor can perform before it must be replaced, but this figure will be controlled by the type of work done, and the skill of the operator and of the mechanics who carry out repairs. Another difficulty is caused by the fact that with the rapid advance in agricultural engineering, the risk of depreciation by obsolescence is considerable. It is impossible in this country to give figures for the life of tractors and implements based on long experience, and even in other countries where machinery has been in use for many years such figures are rarely published. A report by the National Farmers' Union of Great Britain, however, gives the following guide to the relative length of life of various machines in the United Kingdom:—

* C.O.L.A. = Cost of Living Allowance.

TABLE I.

Costs per hour (including depreciation) of some Mechanical Cultivations. (calculated).

No:	OPERATION	Running Costs			Tractors					Implements							
		Fuel	Operator and Labour	Total Running Costs	Depreciation 10,000 hours	Depreciation 5,000 hours	Repairs and Maintenance 100 per cent	Repairs and Maintenance 50 per cent	Total Overheads on Tractors	Depreciation 15,000 hours	Repairs and Maintenance 100 per cent	Repairs and Maintenance 50 per cent	Total Overheads on Implements	Total Cost per Hour	Area Cultivated per Hour	Running Cost per Acre	Total Cost per Acre
		\$ c.	\$ c.	\$ c.	\$ c.	\$ c.	\$ c.	\$ c.	\$ c.	\$ c.	\$ c.	\$ c.	\$ c.	\$ c.	\$ c.	\$ c.	\$ c.
I.	D.8 with bulldozer removing rubber stumps. Page 52 ..	2.12	0.88	3.00	3.30	—	3.30	—	6.60	0.64	—	0.32	0.96	10.56	1.00	3.00	10.56
II.	D.4 with bulldozer filling silt pits. Page 62 ..	1.12	0.81	1.93	1.20	—	1.20	—	2.40	0.43	—	0.22	0.65	4.98	0.31	6.23	16.06
III.	D.4 with 'Prairie Buster'. Page 59 ..	1.13	0.81	1.94	1.20	—	1.20	—	2.40	0.05	—	0.02	0.07	4.41	0.26	7.46	16.96
IV.	D.4 with 3-furrow disc-plough in *belukar*. Page 61	0.97	1.06	2.03	1.20	—	1.20	—	2.40	0.06	—	0.03	0.09	4.52	0.20	10.15	22.60
V.	D.4 with heavy disc-harrows (twice). Page 61 ..	1.10	0.81	1.91	1.20	—	—	0.60	1.80	0.05	—	0.02	0.07	3.78	0.57	3.35	6.63
VI.	Fordson with 2-furrow digger plough. Page 61	1.88	1.06	2.94	0.48	—	—	0.24	0.72	0.05	—	0.02	0.07	3.73	0.12	24.50	31.08
VII.	Fordson with 4-furrow disc-plough in dry land. Page 59 ..	1.70	0.81	2.51	0.48	—	—	0.24	0.72	0.04	—	0.02	0.06	3.29	0.40	6.27	8.22
VIII.	Fordson with 4-furrow disc-plough in padi land. Page 59 ..	2.25	0.81	3.06	0.48	—	—	0.24	0.72	0.04	0.04	—	0.08	3.86	0.75	4.01	5.15
IX.	Fordson with light disc-harrow (5 times). Page 59 ..	1.75	0.81	2.56	0.48	—	—	0.24	0.72	0.05	—	0.02	0.07	3.35	0.43	5.95	7.79
X.	Rotary Hoe cultivating. Page 64 ..	0.60	0.28	0.88	—	0.30	—	0.15	0.45	—	—	—	—	1.33	0.20	4.40	6.65

Track-laying tractors	8.0 years.
Four-wheeled tractors	7.6 ,,
Tractor ploughs	11.9 ,,
Disc-harrows	9.9 ,,
Grain drills	10.7 ,,
Mowing machines	14.6 ,,
Sweeps	10.4 ,,
Binders	11.7 ,,
Combine harvesters	7.7 ,,
Bailers	14.4 ,,

The tractors in the table above will be employed probably on not less than 250 days per year and they will work on an average 6 hours per day so that it will be reasonable to write them off in 10,000 hours, but in the case of tractors of smaller h.p., their life may be considerably less. The case of implements is more difficult but a total life of 5,000 hours is probably reasonable.

Table I summarises the calculated costs per hour of the various methods of mechanical cultivation which have been tried. To estimate the average cost of repairs is more difficult than to obtain one for depreciation, but it is clear that it cannot be accurately represented as a percentage of the cost of the tractor as, in some cases, a higher cost price is originally paid with a view to saving on maintenance and repairs in later years. In the table, however, the figure of either 100 per cent. or 50 per cent. of the total depreciation, according to the envisaged life of the tractor or implement, has been added, and it may be considered to include a figure for housing, insurance, and interest.

Summary.

An overall review of the conclusions drawn from the exploratory investigations carried out on the mechanical cultivation of both wet and dry padi in Malaya in 1947, together with some deductions, is given. A method of calculating costs is demonstrated together with actual costs incurred for certain operations during preliminary investigations.

INVESTIGATIONS INTO THE MECHANICAL CULTIVATION OF WET PADI ON COASTAL CLAYS IN PROVINCE WELLESLEY

BY

H. J. SIMPSON,

Agricultural Officer, Penang and Province Wellesley,

AND

C. W. S. HARTLEY,

Agricultural Officer-in-charge, Central Experiment Station, Serdang.

Introduction.

It was decided that exploratory investigations with considered suitable kinds of available tractors and implements should be conducted in coastal clays as soon as conditions were considered likely to be favourable for mechanical cultivation. In Province Wellesley, 'pans' are of common occurrence in the clays, and areas representative of this condition were sought. Several difficulties were immediately apparent, the more important of which were the small size of the fields in long-established padi areas consequent on the continual splitting up of lots according to the laws of Mohamedan inheritance, and the reluctance on the part of some owners of the lots to allow mechanical trials to be made on their fields. Finally, through the good offices of the penghulu in getting the consent of the owners, two areas in the north of Province Wellesley were chosen, each of 10 to 15 acres, one at Lahar Yoi and the other at Kepala Batas. These areas, although not possessing a controlled water supply, were otherwise suitable in view of their being long and narrow and close to a Government Farm where a limited variety of tractors and implements was available.

The investigations were conducted under two quite different soil conditions as alternate wet and dry periods were experienced. Many of the cultivations were carried out under relatively dry soil conditions typical of periods during the off season when the land becomes hard and baked, while others were carried out under the flooded conditions usually encountered before planting. During the dry periods it is almost impossible to use buffaloes as the land is too hard and the lack of water causes considerable hardship to the animals if they are worked hard. Little or no work therefore goes on, until the rains or irrigation water have softened the land.

Tests at Lahar Yoi.

The first period of testing included two tests. The first of these was started at Lahar Yoi on 14th June, 1947, following a week of dry weather and continued intermittently for 10 days. Some plots in the area were dry and hard, others in the vicinity of the drain were, at their lower elevations,

still soft with standing water such that a man walking on these plots sank down to the 'pan' a depth of 4 to 5 ins. The water was surface water, the true water table being at the time about 17 ins. below the surface of the ground. (This " perched " water table is doubtless caused by the existence of the 'pan' and the significance of this on growth of the crop and water requirements is great and must be the subject for separate detailed investigation).

On the dry plots a 'Caterpillar' D.4 track-tractor hauling a light disc-harrow was first tested and it travelled easily and turned satisfactorily. The light disc-harrow, however, made little or no impression on such land, even when weighted.

The unit was then transferred to a wet plot. Here the D.4 ran reasonably well on a straight run with the tracks sinking down to the ' pan.' The greatest difficulty, however, was experienced in turning it round at the headlands and in negotiating deep soft patches. The method of turning by means of using one track only while the other swivels round is most unsuitable for *sawah* work for two reasons; firstly, the single track is insufficient to pull the tractor and implement round and it slips badly, and secondly, the other track causes great displacement of soil when it swivels. (On one occasion the D.4 failed to get round at the end of a plot and stopped with one track on each side of a *batas*. The *batas* then had to be dug away from underneath).

If a deep soft patch is encountered the D.4, which has very little clearance between the tracks, may 'sit' on the mud with both tracks revolving but making no headway. Plate I shows the deep tracks made in a soft patch when the D.4 was unable to pull the disc-harrow and the tracks just skidded round. Luckily the D.4 came out when disconnected from the harrow and was able to pull it away working from a shallower patch from the side. The disc-harrow, in contradistinction to its ineffective work on dry plots, gave fairly satisfactory cultivation on the wet plot. The clods are not turned right over but the action of the implement brings up enough mud to cover the grass, and cultivation is effected down to the ' pan.' As the land became drier and stickier the disc-harrow was harder to pull and began to carry large quantities of mud in front of it.

Early tentative conclusions reached were that (a) the D.4 is a clumsy and unmanageable tractor for use in the wet soil conditions of the test and (b) the light disc-harrow is as a tillage implement by itself valueless on any but very wet land where it can slip through the soft mud easily. Where rainfall is sufficient to soften the clay and to cause standing water—the latter preventing adhesion of the clay—it is possible that tillage might be carried out with this implement alone. In these conditions approximately three-quarters of an acre was disc-harrowed twice in 2½ hours.

On 16th June, the second test was conducted with a 'Caterpillar' D.4 and a Standard Fordson with steel wheels, each trailing a 2-furrow mouldboard plough. Heavy rain had fallen on the previous night and the dry

and hard plots mentioned above were now softer and with some standing water. The soil, however, was not so soft that a man walking would sink down to the 'pan', though in certain parts the tractors' wheels or tracks did so.

As regards traction in these conditions the same difficulties were encountered with the D.4 as in the first test on the wet plots, though, the land being drier, the difficulty in turning was not so pronounced. This test left little doubt that the D.4 is a clumsy tractor even in these semi-wet conditions. It may be mentioned here that a further disadvantage of the D.4 is the tendency for the mud to cake on the tracks so that the strakes on the track lose their effect.

The Fordson pulled well and ploughing proceeded fairly satisfactorily as can be seen in Plate II; no wheel slipping occurred and cornering was accomplished with little or no skidding even in the wettest parts.

The plough used was a trailed 2-furrow mould-board plough supported by land and furrow wheels and rear wheel. The problem in working with this type of plough, designed for dry-land, is that under the conditions of the test the land wheel sank so that the depth of ploughing was 5 ins. or more in the softer places and it was often much more. The local Malays considered this ploughing too deep, but for reasons noted earlier, this matter will be a subject for special investigation. Covering the wheels with metal discs as illustrated in Plate III greatly assisted ploughing and turning by preventing clogging.

The second period of testing lasted from 12th to 16th July in the middle of four weeks of dry weather. The Fordson only was used as the power unit to trail the mould-board. The whole area was satisfactorily ploughed with the exception of a few dry areas which the shares could not penetrate on account of a plough setting suited to ploughing soft conditions.

Attempts to create a tilth with a spring-tyne harrow by breaking down the furrow slices, which were hard and dry after four weeks of exposure, were unsuccessful, the tynes merely dragging over the clods which were so hard as to break one of the tynes. A Cambridge Roll was then tried; two rollings along the furrows made it possible subsequently to cultivate with the spring-tyne harrow. Harrowing was done twice, followed by two cross rollings and two cross harrowings. The effect is shown in Plate IV.

The following is a summary of the work done at Lahar Yoi:—

	Period	Hrs. worked	Area	Acres per hour
Disc-harrow (D.4) ..	14.6.47	6	0.75 acres	0.13
Ploughing (twice) ..	12-16.7.47	63		
Ploughing Fordson (once)	16-24.6.47	31		
		94	14.15 „	0.15
Cambridge Roll (Fordson (four times) ..	19-28.7.47	42	13.85 „	0.33
Spring-tyne harrow (Fordson) (four times)	19-28.7.47	51	13.60 „	0.27

PLATE I.
'Caterpillar' D. 4 with light disc-harrows.

PLATE II.
'Standard Fordson' with 2-furrow mould-board plough.

PLATE III.
The mould-board plough showing the disc wheels.

PLATE IV.
'Standard Fordson' with the Cambridge Roll.

Hours per acre (overall time)

Plough (once)	6.6 hours.
Disc-harrow (twice)	8.0 „
Cambridge Roll (four times)	3.0 „
Spring-tyne harrow (four times) ..	3.8 „

It must be realised that these times include numerous stops occasioned, for example, by the bending of the plough-axles and bogging of the tractor in deep places.

Trials at Kepala Batas.

Tests were started on 1st July. Ploughing was carried out with a Fordson and a 2-furrow mould-board plough in very wet conditions at the start followed by gradual drying. By 10th July, 7.88 acres had been ploughed in a working time of 42½ hours.

After ploughing, very dry weather set in and the plough ridges became very hard. On 31st July, a disc-harrow was used instead of the Cambridge Roll as at Lahar Yoi, followed by a spring-tyne harrow. The first discing made very little impression on some of the hard ridges, but two discings along the ridges followed by cross discing brought the land to a fair state of tilth. The discing was followed by two runs with the spring-tyne harrow.

On 1st August, 3 ins. of rain fell and the area from being extremely dry became very wet. The disc-harrow continued to be employed, and ran quite satisfactorily in the very slippery conditions. (Plate V). The requisite condition for planting was obtained without having to resort to cross-harrowing. The spring-tyne harrow also ran well in the wet conditions (Plate VI).

Dry weather followed and, as the land dried out, soil conditions became progressively stickier and increasing clogging of the implements took place. This caused greatly increased drag on the tractor and constant wheel slip. It was just possible to finish these operations under these sticky conditions, which are undoubtedly the worst conditions for working this type of land. The land is much more easily worked in wetter conditions.

Below is a summary of the work at Kepala Batas:—

	Period	Hours worked	Area
Ploughing (wet) ..	1-10.7.47	42½	7.88 acres.
A. Work in drier conditions.			
Disc-harrowing (3 times) ..	31.7.47	5	1.86 „
Spring-tyne harrow (twice)	1.8.47	4½	1.86 „
B. Work in wetter conditions.			
Disc-harrowing (twice) ..	1-6.8.47	11	6.02 „
Spring-tyne harrow (twice)	2-6.8.47	9½	6.02 „

Hours worked per acre (overall time)

Ploughing	5.4 hours
Dry. Disc-harrowing (3 times) ..	2.7 „
Spring-tyne harrowing (twice) ..	2.4 „
Wet. Disc-harrowing (twice)	1.8 „
Spring-tyne harrowing (twice) ..	1.5 „

The method of harrowing twice was to half overlap the previous harrowed strip. It must be appreciated that the above figures are to a great extent rough ones as a daily varying number of unexpected difficulties were encountered.

It is certain that more economical working would be possible with more working experience and consequently fewer interruptions. They are merely statements of work done under *sawah* conditions and are not rates of work on uninterrupted runs.

It is pertinent to compare these times with the times taken in buffalo ploughing and harrowing as given by an experienced padi planter in the same area.

Ploughing	..	**1 acre**	**6 days**	**(6 hour day)**
Harrowing (3 times)	..	**1 „**	**4½ „**	**(6 „ „)**
			10½ days	**= 63 hours.**

It is generally considered that 8 *relongs* (1 *relong* = 1⅛ acres in Province Wellesley) is the maximum one man and one buffalo could possibly do. If this is reduced to the round figure of 10 acres it is clear that the padi planter would have to start operations over 3 months before planting. In practice this is often done in Province Wellesley North, though holdings of 10 acres are very uncommon.

After a spell of continuous dry weather the position at Kepala Batas in the middle of August was that the ground was extremely hard and covered with almost brick-like clods. Following subsequent heavy rains a certain amount of softening took place, but in general the hard brick-like clods remained unaltered ever after a week's inundation. It then became obvious that, although during the first period a reasonably satisfactory condition for planting had been obtained, that condition was of a very temporary nature and the land, during the relatively dry weather, had become very consolidated on the surface and totally unsuitable for planting without further cultivations.

It is possible that these subsequent operations would have been unnecessary if controlled irrigation had been available and the land had been flooded after each of the earlier operations, as it was the alternate drying out and inundation of the fields that caused the formation of brick-like clods and also encouraged weed growth.

The first implement to be tried was the Cambridge Roll. This had done good work in drier conditions at Lahar Yoi, and it was hoped that it would exert a puddling effect. The implement, however, proved to be a complete failure, becoming completely bogged down in a few yards.

A 4-furrow disc-plough with the rear disc removed was next tried. This did good work when the discs were set at their maximum height out of the ground. The Fordson had no difficulty in pulling it along the straight but some stalling and difficulty were experienced on sharp turns. This was

PLATE V.
Work done by the disc-harrow in wet conditions.

PLATE VI.
Work done by the spring-tyne harrow in wet conditions.

aggravated by the fact that the discs cannot be lifted at headlands on this particular type of plough and as a result these areas became extremely soft and churned up. During the course of a morning, approximately 4 acres of land were ploughed, and work was proceeding extremely well until the land-wheel bearing of the plough broke as the result of too much drag.

Early in September an R. 4, the petrol-driven counterpart of a D. 4, which had been fitted with lugs to overcome the tendency to skid when cornering in soft ground, was received. The fitting of these lugs proved to be a great success as the machine was able to manoeuvre easily and could be made to turn in its own length. The machine however cannot be recommended as it proved very expensive to run and the wheel tracks left deep wide ruts with the soil piled up in ridges between the tracks. This fault is not confined solely to the heavier machines like D.4's and R.4's but occurred with Fordsons. It is however one that must be overcome as it was found that when the water level dropped even a few inches the furrows above water rapidly became very hard and brick like.

The next implement to be tested was a cut-away disc-harrow which had done excellent work in clearing grass and *belukar* at the Central Experiment Station, Serdang. The implement however was too heavy for work in the *sawah* in its then wet condition. The Fordson completely failed to pull it and the R.4 managed less than one length when the implement became bogged down.

One of the main causes for this continual bogging of all trailed implements when being used in soft conditions is the sinking of the tractor itself, which results in the draw-bar sinking to ground-level or even below. When this happens any implements being towed behind are drawn down into the ground and the soil rides up in front in the form of a bow-wave. This naturally increases the draught to an extent that no medium-powered machines can draw their commonly associated implements and the use of heavy weight power units would probably break the implements.

At Lahar Yoi the area became very dry with the soil becoming very hard and developing a baked consolidated crust. Before the land was in a fit condition for re-cultivation, which was not until late September, all suitable machinery had been transferred to Pahang Tua and no further mechanical trials were carried out.

The failure of machinery to complete cultivations under wet conditions at Kepala Batas, which in effect amounted to a second set of cultivations on land that had already been brought into a suitable condition for planting, necessitated the use of buffaloes. All areas were re-ploughed once and harrowed two and sometimes three times. It was found that the previous machine cultivation had however reduced the time required to cultivate by means of buffaloes to approximately half. Planting of the area was completed by 4th October.

Similar work was carried out at Lahar Yoi but in general an extra harrowing had to be done in order to reduce the hard-brick like clods that

took a long while to soften down. Planting in this area was not completed before 22nd October.

Later History.

KEPALA BATAS.

The padi grew very well in this area and at flowering time was several inches taller and very much thicker than padi in neighbouring non-mechanically cultivated areas. Although the average yield from the mechanically cultivated area was 355 gantangs per acre as compared with 314 gantangs per acre in neighbouring areas, no reliable conclusion can be drawn as the former areas received considerably heavier dressings of manure as the local cultivators were very sceptical about the deep ploughing and the bringing up of raw sub-soil to the surface.

LAHAR YOI.

In this area the padi was more backward than in the surrounding areas and tillering was generally poor as the plants suffered in the early stages from lack of sufficient water. The deep cultivation had opened up the land and consequently it took much longer for these areas to become fully inundated. Although in three small lots the yields were below average, 60 to 80 gantangs per acre only, the remaining lots gave an average yield of 211 gantangs per acre, as compared with 202 gantangs per acre from non-mechanically cultivated areas. The poor yields of 60 to 80 gantangs were chiefly due to the use of over-age seedlings. Here, as at Kepala Batas, heavier manurial dressings were applied to the mechanically cultivated plots.

Conclusions.

1. These trials have shown that it is possible, on padi lands that dry out during the off-season, to cultivate mechanically during that period and to bring the land to a fair tilth under dry conditions or into a condition fit for transplanting under wet conditions. It appears that advantage of this state could only be taken if drilling in the former case and transplanting in the latter can be followed by the presence of adequate water either from rainfall or controlled supply. If it is inexpedient to sow or transplant then, or adequate water cannot be provided, this favourable soil condition is liable to be destroyed by consolidation during a subsequent dry period.

2. It was found in those areas that had been cultivated and where the land had become consolidated again, that, under wet conditions, ploughing, using the ordinary type of trailed implements, was possible but to-date no suitable implement has been found to complete "after" cultivation.

3. The Fordson Major has proved more successful than the 'Caterpillar' D.4 and it is recommended that all further work should be confined to this machine until the smaller 'Crawler' types arrive.

4. The 2-furrow mould-board ploughs used in the early ploughing worked too deep and turned up sub-soil. Under the conditions prevailing it was often impossible to adjust such ploughs for shallow ploughing. In such

cases their place can best be taken by disc-ploughs set to plough not greater than 6 ins.

5. Shallow cultivation can be obtained by: (a) using all precautions to lessen tendency to sink on the part of the tractor and implements, (b) raising the tractor draw-bar to compensate for any sinking and (c), using, preferably, tractors with integral implements. In all cases extension rims should be fitted to the wheels of the tractors and to the implements and, where necessary, the tractor draw bar raised.

Acknowledgment.

We wish to express our indebtedness to Inche' Min bin Haji Ahmad, Agricultural Assistant, for his assistance in making arrangements with the cultivators, without which the trials could not have been started, and to Mr. J. A. O. Beasley, Food Production Officer, and his team of workers who carried out these trials. They often worked under very great difficulties, especially during the latter part of the season when bogging of machines and implements became more and more frequent.

INVESTIGATIONS INTO THE MECHANICAL CULTIVATION OF WET PADI ON COASTAL CLAYS IN THE STATE OF PAHANG

BY

J. R. Curry,

State Agricultural Officer, Pahang.

The Pahang Tua and Langgar *mukim* padi areas occur within the deltoid region of the Pahang River, roughly in the middle of the east coast of Malaya. They are irrigated by means of a pumping scheme. The total area extends to 3,000 acres, of which about 1,000 acres have already been cleared and cultivated. Before the recent Japanese war development of this area was incomplete by reason of lack of local people willing to take up residence in the area; this reluctance can in part be explained by the high local incidence of filariasis and elephantiasis. During the past two seasons development of the area has been further handicapped by mechanical trouble with the pumping equipment, and in the planting season of 1947, i.e., around September, it appeared that large areas might not be planted as the people had become discouraged. It was decided to send machinery to the area to serve the double purpose of assisting cultivators to plant the maximum acreage and to gain experience in the problems of mechanical cultivation of padi land on coastal clay soils.

The tractors and implements arrived in the fourth week of September and for the next five weeks conditions were favourable for ploughing operations. There were large areas of old padi fields, free from stumps, carrying only one year's growth of swamp grasses, and the weather remained unusually dry.

Three steel-wheeled and one rubber-tyred Fordsons were tried and the implements consisted of two disc ploughs, two mould-board ploughs and one double-banked disc-harrow. The rubber-tyred tractor was entirely unsuitable as it could not grip the ground even when the land was at is driest; the mould-board ploughs were also unsuitable on land carrying a strong grass growth, but they could plough land with short grass quite satisfactorily. Following these initial trials work was confined to ploughing the maximum area with the metal-wheeled tractors and disc ploughs.

The total area ploughed was not impressive, mechanical breakdowns in the tractors were numerous, spares were difficult to obtain and, also, workshop facilities were far distant. New and old buffalo wallows were a constant source of trouble as they could not always be detected, and a tractor bogged in a wallow could take hours to extricate, requiring the assistance of the other units.

The notes which will now follow are a brief account of the experience gained in the problems of the mechanical cultivation of padi land of this description. The over-all costs of the undertaking in relation to the acreage ploughed will obviously be no guide in estimating the acreage costs of mechanical ploughing. The operators could not be fully employed and in addition eight local apprentices were engaged for training; 140 acres were ploughed and 10 acres harrowed at an over-all cost of $20 per acre for fuel and labour.

During the early stages of the operations, the Fordson tractors could operate with the normal spiked, steel wheels; when the surface of the land was dry and a full uninterrupted day's work could be performed, one unit could plough a maximum of 8 acres in an 8 hour day. A wet surface could reduce the performance to as low as 4 acres per day, fuel consumption remaining the same. The following figures indicate the running costs per acre, given normal conditions:—

Running Costs	Per 8 hour day	Per hour
(1) Fuel cost ..	$18.00	$2.25
(2) One trained operator ..	4.48	0.56
(3) One labourer ..	2.00	0.25
Total ..	$24.48	$3.06

Running Costs per acre.

(1) Dry conditions at 8 acres per 8 hour day ..	$3.06
(2) Medium conditions at 6 acres per 8 hour day ..	4.08
(3) Wet conditions at 4 acres per 8 hour day ..	6.12

Towards the end of the period the rains commenced and the land became too wet for tractors equipped with normal wheels. Further operations were only possible by placing two sets of rear wheels on one tractor. Thus equipped with double-width driving wheels the tractors performed prodigious feats and, under conditions in which a man walked up to his knees in mud and water, 4 acres could be ploughed in 8 hours.

Conclusions.

The area was re-visited about three weeks after ploughing had ceased. The people were busy with the final puddling and transplanting had commenced. The pump had been unable to work at full capacity; the irrigation is by inundation and the water supplied is flooded over large tracts of land and all the area ploughed had not been fully submerged. In consequence grasses and weeds had appeared to an extent which would not have occurred had the land been quickly and completely flooded after ploughing. But even so, a long interval between ploughing and planting is clearly undesirable since weeds will grow no matter how dry or wet the

soil may be; under Pahang Tua conditions the subsoil will always be sufficiently damp to induce a strong weed-growth. This factor must in some degree offset the lower costs of dry ploughing, but it is evident that quite new techniques may be necessary, and specially constructed tractors and new machinery may be evolved after experimentation. From the limited experience so far gained the other problems that remain may be posed as follows:—

(a) In any given padi area being treated mechanically the planting programme must be completed within the usual statutory time limits, since pest and disease control and utilisation of irrigation facilities make it necessary for a locality to follow a common planting programme.

(b) Operations should not commence too far ahead of planting for the reasons discussed above. There is an optimum ratio of mechanical equipment to acreage which must be determined. Although this is obvious, and is true of any agricultural undertaking, the solution may not be so easy as in ordinary dry farming. In padi cultivation, equipment may either have to stand idle for long periods between seasons or be transported long distances to areas with a different planting season.

INVESTIGATIONS INTO THE MECHANICAL CULTIVATION OF WET PADI ON PEAT SOILS IN THE STATE OF PERAK

BY

E. F. ALLEN,

Agricultural Officer, Perak South,

AND

E. W. BEWLAY,

Food Production Officer, Sungei Manik.

Introduction.

It was decided to concentrate investigations into the mechanical cultivation of wet padi on peat soils on Stage IV of the Sungei Manik (South Perak) Irrigation Scheme, and the following programme was designed, the items being shown in order of priority.

(a) Clear a block of all timber and stumps and hand-plant it with padi so that a large area should be available for mechanical harvesting trials early in 1948.

(b) Investigate the possibilities of mechanical removal of stumps and buried timber.

(c) Cultivate the land dry with whatever machines and implements were both available and suitable.

(d) Test the possibility of sowing by drills.

Accordingly a block of 324 acres, irrigated by distributary No. 7—2L, under heavy *belukar* and jungle stumps was reserved and work commenced on 48 acres nearest the road. The soil is a soft peat, 1 to 3½ ft. deep, overlying a sandy clay; there are two sandy outcrops on the area but, as a whole, it is very level with a gentle slope of 1:900 to 1:1,400. The block was divided into three by subsidiary drains and the spoil from the two internal drains was used to construct extra distributaries. Even with this extra drainage the land dried out very slowly indeed as the sponge textured peat proved very retentive of moisture.

Preliminary Tests.

A 'Caterpillar' D.4 tractor with standard width tracks was put on a well-drained portion of a drainage reserve adjacent to the land and found to be unsuitable as its bearing-pressure was too high. In each test the tractor sunk into the peaty soil after running less than half a chain. As a result of these preliminary trials it was decided to purchase some second-hand Weasels (amphibious cargo-carriers) from the Army. Three of these machines were received during June and one was overhauled and made

serviceable. This machine was found capable of towing a disc-harrow over partially-stumped land covered with lalang grass and light secondary jungle growth. Even on bare patches of soil with water on the surface the rubber-faced Weasel tracks showed no tendency to sink and it was calculated that the bearing-pressure was about 1.9 lbs. per sq. in. After several short tests it was decided that, before cultivation could commence, all stumps and surface timbers would have to be removed. It was obviously necessary to do this before any ploughing could be done and equally desirable in order to prevent undue damage to implements.

Clearing and Stumping.

An attempt was made to remove the stumps and buried timbers mechanically but this proved a major undertaking involving many technical problems. It was found necessary to slash the heavy lalang grass by hand before this could be burnt. When this was completed over a few acres nearest the road, stumping commenced using a 'Hyster' winch on the back of a D.4 with the tractor on the road. This method had several disadvantages, chief of which were as follows:—

(a) As the 'Hyster' winch has no fair-leads it had to be pointed accurately towards the stump being pulled out in order to prevent damage to the rope. This caused much manoeuvring on the road with consequent damage to the soft earth surface.

(b) When an attempt was made to pull out a large stump the whole tractor skidded.

(c) Not more than 200 ft. of wire rope could be used conveniently on the drum.

It was decided, therefore, that the tractor would have to be inside the area to be stumped and an attempt was made to cross the main drain in August. However, the steel bridge-sections which had proved quite adequate for the Weasel collapsed under the tractor weight and it took three days to extract the machine. Subsequently a timber bridge was constructed and the tractor crossed the drain in September but had to be kept on an apron of steel and timber to prevent it from sinking in the soil. Its comparative inability to manoeuvre on this apron made it essential to devise a method whereby stumps could be winched out even when they were out of line from the winch-drum. A lay-out was evolved which is illustrated in the plan on the opposite page. Briefly it involved the following:—

(a) Anchoring the forward end of the tractor to a heavy timber using a 'Trewhella' winch for convenience.

(b) Passing the tow-rope through a snatch-block which was kept opposite the winch-drum by anchoring it to another timber with a second 'Trewhella' winch.

For winching operations ½ in. wire-rope was used at first but this proved both dangerous and unsatisfactory as it broke repeatedly. A light chain was used to fasten the rope to the stump to be extracted. Subsequently

DIAGRAM OF WINCH STUMPING

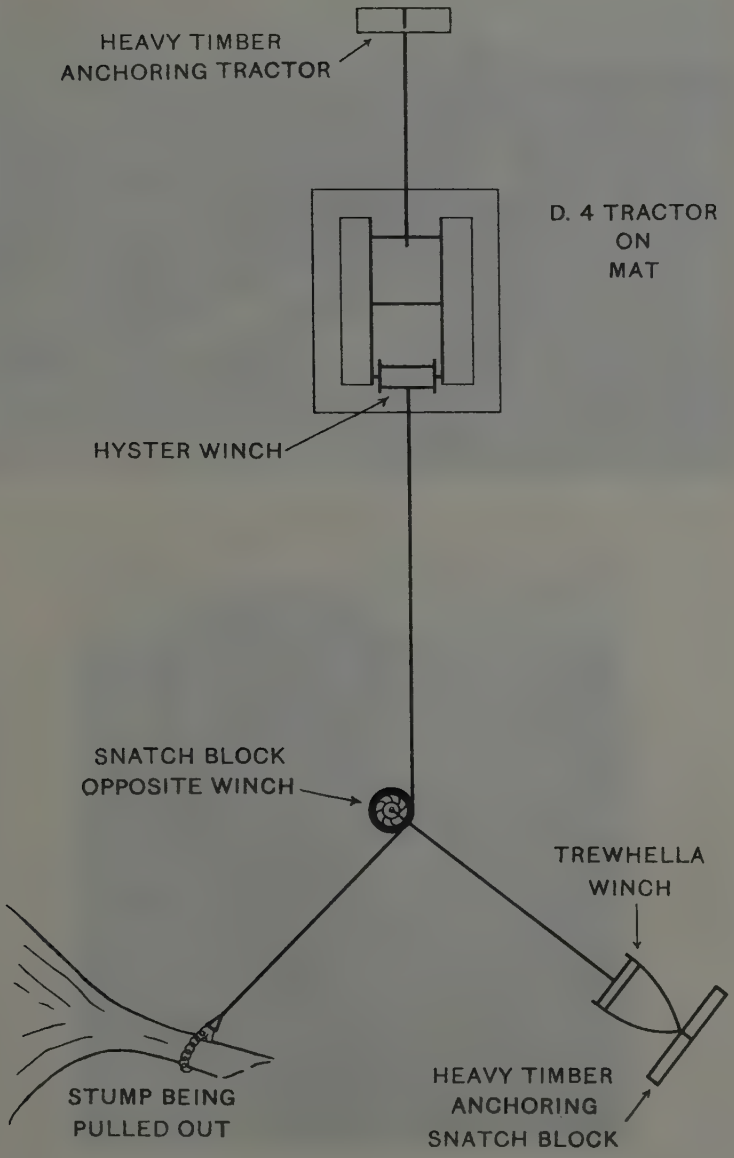

PLATE I.
The 'Weasel.' The method of crossing the main drain is shown.

PLATE II.
'Caterpillar D.4 on the 'apron', showing winch.

PLATE III.
"Stumping" in progress showing the craters formed and the lying timber.

PLATE IV.
Horizontal trunk being removed.

¾ in. wire-rope was ordered in several lengths, but these were not received until October. Thereafter stumping went ahead slowly but steadily and eventually about 4.8 acres were stumped mechanically.

Meanwhile in August it was realized that most of the area would have to be stumped on contract and successive blocks were given out progressively. This work apparently proved very much more arduous than was expected and considerable trouble was experienced with certain contractors. However, the whole area was eventually cleared of all large stumps and timbers to a depth of 1 ft. by the end of November. The area stumped mechanically was cleared to a much greater depth but it is not yet certain whether this is a real advantage. Very large holes are left when stumps are winched out and these have to be filled in by hand. However, it was found desirable to delay this filling in until the completion of cultivation in order to prevent the patches of soft earth from acting as tractor traps. The contract cost of stumping averaged $282 per acre. (Plate III & IV).

A mechanical saw was tested during stumping and it was found very useful indeed for cutting up large logs prior to stacking and burning. These saws can cut vertically, horizontally or at an angle of 45° up or down. In actual practice only the vertical cut is feasible as the machine is otherwise too heavy for two men to hold during continuous operation. It was also found that vibration on the neck-strap made the work much too exhausting for the operator, and for prolonged operations it would be more economical to use a gang of three men.

Cultivation.

Once the land had been cleared of surface stumps and timbers the work of cultivation commenced and involved no very great technical problems apart from the maintenance of the Weasels in a serviceable condition. Problems of Weasel maintenance are treated in a separate section.

A 4-furrow disc-plough proved too heavy for the Weasel and it was converted into a 3-furrow plough. Even then it was of very heavy draught and the rear wheel caught up very readily on sub-surface timbers. Subsequently this plough did very good work but it is made of inferior material and eventually disintegrated.

The two-gang disc-harrow was also much too heavy for the Weasel although it was at one time the only implement available which was capable of cutting lalang grass. With the gangs fully opened up the draught is heavier than that of the disc-plough.

The light four-gang disc-harrow (Plate V) did good work where the lalang grass had been slashed and burnt but it was not of sufficiently robust construction to stand up to rough use. Even before receipt it had obviously been damaged frequently and repairs with angle-iron had spoilt its effectiveness except for use as a covering-harrow. However, a simple modification resulted in more uniform deeper cultivation, especially when the rear gangs were weighted with scrap metal.

The medium size cut-away disc-harrow (Plates VI and VII) proved by far the most successful implement and it was responsible for the entire cultivation of 28 acres. The cut-away discs cut up and buried the lalang grass much more effectively than the plain discs, and the implement was of a suitable weight for the Weasel. Unfortunately it was received with one structural member cracked and this eventually broke. However, it was kept in operation by temporary repairs.

Actual cultivations performed were as follows:—

Block A:

1st cultivation: 4 acres of heavy lalang grass were disc-ploughed; then the plough broke up and the remaining 24 acres were disc-harrowed.

2nd cultivation: The whole area was cross-harrowed partly with the cut-away disc-harrow and partly with the light disc-harrow. This left the land in a state suitable for flooding with water and subsequent transplanting.

3rd cultivation: Block A.1, which was reserved for drilling trials, was then disc-harrowed once more in order to increase consolidation of the surface soil.

4th cultivation: An attempt was made to harrow block A.1 with a spring-tyne harrow and to roll it with a Cambridge Roll. Both cultivations had to be abandoned as the soil was by then too wet to be suitable, as it rapidly chocked up with dead lalang grass and lumps of peat.

Block B: This was disc-harrowed until the lalang grass and other vegetation had been eradicated. In practice it was found necessary to cultivate the whole 28 acres twice and 11 acres a third time. On this latter area the lalang grass had been taller than elsewhere.

Block C: By the time stumping had been completed on this area the water-table was very close to the surface owing to seepage from Distributary 7—3L. Hence an attempt to cultivate by light disc-harrow was finally abandoned on 3rd December after less than 2 acres had been harrowed. However, stumping operations had left much of this land quite clean so it may be possible to plant the area by hand.

Operation and Maintenance of Tractors.

The problems of Weasel maintenance were considerable as all these machines were unserviceable when received. However, they were believed to be the only type of tractor capable of working on the soft peaty soil. Initial modifications made to the first machine were as follows:—

(a) Removal of unnecessary military fittings and re-wiring.

(b) Removal of the superstructure in front of the radiator in order to improve visibility.

(c) Substitution of a gravity-feed petrol tank for the much larger pump-feed tank.

(d) Removal of the track-covers to facilitate maintenance and inspection.

In addition major overhauls were found to be necessary to the engine, transmission and starter.

PLATE V.
The light disc-harrow drawn by the 'Weasel.'

PLATE VI.
The 'cut-away' disc-harrow drawn by the 'Weasel.'

PLATE VII.
The 'second-cut' with the 'cut-away' disc-harrow.

PLATE VIII.
The modified 'Caterpillar' D.4 drawing a 3-furrow disc-plough.

Experience proved that the Weasel's chief disadvantages were as follows:—

(1) It was designed as a medium high-speed vehicle and in consequence it has a very wide radius of turn.

(2) When run continuously it tended to over-heat. This was attended by numerous problems such as ignition trouble, starting difficulties, hardship to drivers and heat-damage to batteries. One example of these problems is the sudden destruction of two batteries due to melting of their cases.

(3) Running costs were high. Fuel consumption was about 4 gallons of petrol per hour.

(4) The No. 1 machine could not be started by hand or by pushing. Whenever the starter-motor failed to work the only method of starting was by towing. There was considerable risk, therefore, when this machine was operated beyond the towing range of other tractors.

(5) The tractor plates could not be replaced individually; the whole track was a single unit with the plates jointed with rubber-covered wire. No spare tracks were available.

(6) The lack of a spares service meant that many replacement items had to be specially made.

Since extra tractors were essential and the No. 1 Weasel was proving most uneconomical to maintain, the best 'Caterpillar' D.4 tractor was modified as follows:—

(a) The bulldozer blade and power-control unit were removed to reduce weight.

(b) Hard-wood shoes were bolted on to the track plates to give an additional track width of 13 ins. thereby halving the bearing-pressure. The size of each shoe was 2½ ins. x 6½ ins. x 26 ins. This modified D.4 was found to be capable of working on quite soft soil although its bearing-pressure was greater than that of the Weasel. Contrary to expectations these modifications did not impair steering ability. However, the centre of gravity of this machine was too far aft and its stern always tended to sink in soft patches. Nevertheless quite good work was done with this tractor although it had sometimes to be winched out of holes as often as three times in a working day.

The first D.4 tractor (Plate VIII) to be modified had one serious mechanical defect, namely that the track extension overlapped only on the outside. This put most of the weight on the outer rollers which would eventually lead to trouble. Accordingly another D.4 with wide-track assembly, but with standard size 13 in. tracks was obtained. This machine was then fitted with similar extension shoes, 2½ ins. x 6½ ins. x 34 ins., so that they overlapped the metal tracks by 8 ins. on the inside and 13 ins. on the outside. It was estimated that this second D.4 had a bearing-pressure of approximately 2.2 lbs. per sq. in. and it performed quite well although

it suffered to a lesser extent from the same two defects as the first tractor, —uneven pressure on the roller-bearings and centre of gravity too far aft. Nevertheless it became bogged down in deep holes. (Plate IX).

A Fordson Standard Tractor with iron wheels was twice tried on the land under comparatively good conditions. Each time it sunk almost to the axles in the peaty soil and had to be towed out over timber and steel nets. The front wheels are obviously of unsuitable design for soft soil (Plate X) but the rear wheels sunk almost as readily.

Drilling and Nurseries.

Nurseries were due to be planted in the *tali-ayer* 7 area during the second half of September. However, it was found impossible to complete cultivation or even stumping by that date so that land was kept dry and nurseries were sown on a wet portion of Degong Agricultural Station where rain-water could be augmented by pumping. Nevertheless the problem of drilling remained and it was decided to sow Radin Kuning (a 6½ to 7 months padi) in nurseries and to drill with Haji Harun (a 4½ to 5 months padi).

A block of 10½ acres had been reserved for drilling and it was given extra cultivation to that end. Unfortunately very heavy rain on 28th November left the land very wet indeed and the drilling of this area had to be abandoned on 3rd December. This decision was made after both tractor and drill had stuck repeatedly in the soft soil.

A comparatively uniform area of 3 acres in Block B was then marked out and it was decided to attempt to drill this area. Accordingly it was rapidly given an extra disc-harrowing, and drilling commenced on the afternoon of 3rd December and was completed on 5th December. During this operation the two light covering-harrows, received with the drill, were found to be quite useless so a heavy plank was dragged behind the drill in order to cover the seed. The whole area was then consolidated by a Cambridge Roll.

There appeared to be no technical difficulties attached to the operation of drilling. The steel extension rims fitted to this drill should be quite adequate for August-September drilling in a normal year. Even in December the drill showed no greater tendency to stick than the tractor pulling it. However, once the drill does sink into wet soil it is a most troublesome machine to clean as all the feed-pipes become choked up with a mixture of peat and clay.

Suggestions for Future Work.

It is suggested that a crane mounted on a tractor chassis (e.g., T.D.9) should be tested next year. This could remove and stack all surface timber quite cheaply before the larger stumps are winched or pulled out by tractor. This crane could also handle the heavier timbers after they have been pulled out.

It will be adequate if stumps and timbers are removed to a depth of 1 to 1½ ft.

PLATE IX.
'Caterpillar' D. 4 bogged in a crater.

PLATE X.
The 'Fordson' which has broken through the soil crust.

A 'Caterpillar' D.4 tractor should be modified by extending the tracks backwards. This would give a reduced bearing-pressure and move the centre of pressure forwards. It is important to note that this suggested modification would require only a few specially made parts (gear-wheels etc.) as the standard track plates and roller-bearings could be employed. A backward extension of 2 ft., together with an 8 ins. shoe-overlap on each side of the track, would give a bearing-pressure of approximately 2 lbs. per sq. in. This would probably solve many problems.

Acknowledgement.

The authors gratefully acknowledge the help on many matters that they have received from Mr. R. Inglis, Drainage and Irrigation Engineer, Lower Perak, who was also responsible for the drainage and irrigation works.

INVESTIGATIONS INTO THE MECHANICAL CULTIVATION OF WET PADI WITH HORTICULTURAL TRACTORS

*A Compilation from Reports of Agricultural Officers of the Field and Research Branches**

Owing to the obvious importance of tractors of low h.p. to the small-holder, a wide range of types and implements was ordered but few were available for testing in the 1947 planting season, and consequently the number of types tested was small. Tests were, however, organised on coastal clays at Selinsing Padi Test Station in South Krian, Perak, on peats at Sungei Manik, on river alluvial and quartzite soils at Talang Padi Experiment Station near Kuala Kangsar, Perak, and also on the Central Experiment Station, Serdang, Selangor.

Coastal Clays.

A Howard Rotary Hoe, " Gem " type of 6 h.p., equipped with rubber tyres, was received at Selinsing on 30th June and trials were conducted during the first three weeks of August, under variable water and soil conditions. At this Station ploughing is not a normal operation, the usual practice being *menajak*† in which prior to hand clearance by 'skinning' the surface by *tajak*¶, the off-season weed growth, some 18 to 24 ins. in height, is slashed at ground level and left to decompose in the water; there is, therefore, a mat of roots below the surface of the soil which, it was found, was capable of sustaining the implement for at least the first cultivation (Plate 1). It was, however, found that bogging down resulted on numerous occasions, and choking at the off-side end of the rotor-shaft occurred frequently, necessitating numerous stops for clearing. Eventually, it was decided to cut away the off-side end of the rotor-shield, and when this was done there was rather less choking and, when choking occurred, clearing was easier. It was noticeable that under conditions of 3 to 4 ins. of standing water the blades of the rotor and the land wheels shewed less tendency to

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* This article is based on reports submitted by:—

(1) Mr. P. G. Coleman, Agricultural Officer, Perak North (Coastal clays at Selinsing).

(2) Mr. E. F. Allen, Agricultural Officer, Perak South (Peat soils at Sungei Manik).

(3) Che' Ramli bin Haji Tahir, Malay Agricultural Officer, Perak Central (River alluvium, Talang).

(4) Mr. C. W. S. Hartley, Agricultural Officer-in-charge, Central Experiment Station, Serdang.

† *Menajak* = clearance of weed growth preparatory to padi planting.

¶ *Tajak* = a local tool resembling a short-bladed scythe.

PLATE I.
A 'Gem' Rotary Hoe at Selinsing.

PLATE II.
The 'Anzani Iron Horse' at Sungei Manik.

PLATE III.
A modified Rotary Hoe at the Central Experiment Station, Serdang.

PLATE IV.
A 'Trusty Tractor' at the Central Experiment Station, Serdang.

become choked, whereas when the surface held no standing water but was merely " muddy " (at no time was it dry) choking became more frequent and the machine less easy to manage because the land wheels became blocked with mud.

The state of the land after the passage of the rotary hoe appeared to be entirely satisfactory, in that weed growth was cut at between 2 and 3 ins. below soil level on the forward and downward stroke of the blades, was carried up and over the shaft, and on the next downward stroke was buried, thoroughly mixed with mud. The appearance of the finished plot seemed to leave little to be desired, except that there was a certain ridging effect. This was caused by the necessity of having to push aside part of the previously hoed strips to enable the hoe to take a contiguous strip on its next round without slewing and slipping into the previous strip; this operation was found to be essential and was performed by a man following the hoe and clearing a small track with the side of his foot. It is considered that this operation could be done by means of a simple share attached behind the rotor.

The after-results of this cultivation trial have been disappointing in the extreme; the re-growth of weeds has been such that it has been necessary to revert to the employment of the whole gamut of manual cultivation, otherwise it would have been impossible to plant the area at all. This re-growth of weeds was occasioned by two factors: firstly, as a result of dry weather and the fact that, being situated on " high " land, irrigation water was not available until some weeks later and it was not possible to ensure that the cut weeds were adequately covered with water, which would have resulted in their rotting; secondly, it is considered that the growth of the weeds was actually stimulated by the action of the hoe, the re-growth being greater than the off-season growth. This is highly probable in view of the fact that normal cultural operations in that locality result in less deep disturbances of the land than that made by the rotary hoe.

It may well be that in localities where the normal cultivation is by plough or changkol, the rotary hoe may achieve satisfactory results, subject to suitable modifications, as mentioned above, but it would appear that the first essential is that adequate and controlled water should be available to effect " drowning " of the off-season weed flora following rotary hoeing.

Peat Soils.

Preliminary tests with a Howard Rotary Hoe with steel wheels were conducted in very dry weather in July and early August at Sungei Manik Padi Experiment Station on deep moist peat soil. These tests indicated that the machine showed promise but was neither sufficiently powerful nor adequately designed to cope with a heavy off-season growth of tough sedges and grasses. As a rule the blades became severely clogged after every 10 chains of work and it would take two men about 10 minutes to clear away the matted vegetation. Attempts made to carry on cultivation without cleaning the blades resulted in the machine stalling even in bottom gear.

It was, however, considered that the rotary hoe might be suitable for such soils if extension rims were fitted to the wheels.

A trial with an "Anzani Iron Horse" on moist peat padi land at Degong Station proved that it was quite unsuitable for the purpose. Even with steel extension rims fitted to the pneumatic-tyred wheels it was found to have much too high a bearing-pressure and it could not even propel itself. The wheels sank into the moist soil almost to the axles and then spun (Plate II). Considerable modifications will be necessary before further trials can be commenced next year.

River Alluvium.

A series of trials was carried out with a rotary hoe with pneumatic tyres at Talang Padi Experiment Station in Central Perak and from observations made during the trials it was considered that a top soil of uniform texture, low weed-growth and adequate drainage of the land to be worked, were some of the factors required for efficient running of the rotary hoe in shallow *sawahs* of Talang type. In soils with soft and deep patches scattered over the area, difficulty was experienced as the rubber wheels skidded. The depth of cultivation and gear used usually govern the smooth working of the hoe. It might prove useful if during the first operation a shallow cultivation be aimed at followed by a deeper cultivation for the second and third running, but this was not done during the trial. All tall grass should first be cut by reaping machines and removed as most stoppages were due to grass binding the hoe blade and shaft.

The machine was found to work well on land with about 1 in. of water and weeds not more than 3 ins. high. There was no trouble with soil clogging the wheels as the cultivated soil was washed off the wheels fairly quickly. One difficulty encountered, however, was that the off-side wheel was found to sink into the cultivated soil causing the machine to run in an inclined position, when control became difficult. It was considered that the fitting of a cleated cast-iron wheel on the off-side to prevent sinking would be an improvement.

As a result of the above trials, modification to the rotary hoe were discussed with the Representative in the Far East and the local agents, and extensions to the wheels were fitted (Plate III) and tested at the Central Experiment Station, Serdang. The area in which the tests were conducted was a small padi field which had been unplanted in the previous season and which contained a low growth of matted, coarse grasses and weeds. Progress, although slow, was thorough and a good seed-bed was obtained after two cultivations. The blades became jammed constantly, however, and it is considered that considerable alterations will be necessary before it can be claimed that the machine can be used satisfactorily in wet padi fields.

Several other types of horticultural tractors, for example, the "Trusty Tractor" shown in Plate IV, have now been imported and they are being tested in dry conditions at the Central Experiment Station, Serdang, in preparation for the padi season.

INVESTIGATIONS INTO THE MECHANICAL CULTIVATION OF DRY PADI ON CLEARED LAND

BY

J. R. P. SOPER,

State Agricultural Officer, Selangor,

AND

F. R. MARSHALL,

Food Production Officer, Sungei Buloh.

Introductory.

When the Short Term Food Production farms were re-organised in April 1947 it was decided to investigate at Sungei Buloh in Selangor the application of mechanical methods to dry padi cultivation. An area of about 200 acres was originally suggested, but in order that equipment should not lie idle and also to give some information on the optimum time of sowing, the acreage finally cultivated was 270 acres. This comprised field No. 1 of 65 acres, No. 2 of 65 acres, No. 3 of 75 acres, No. 4 of 26 acres and No. 11 of 39 acres.

Field No. 1 had an eight-month growth of natural herbage, mainly grasses. No. 2 had a similar growth, but was given a preliminary cut with heavy discs in early June. A crop of groundnuts was sown on No. 3 in April and was harvested at the end of July. Groundnuts were harvested off No. 4 in March; it was given monthly cuts with heavy discs in May, June and July in an attempt to eliminate weed growth. No. 11 was drilled with *Calopogonium* in late April, but the cover did not grow well and there were many natural weeds when cultivation started in July.

Soil.

The soil is a light, sandy loam fairly typical of inland quartzite formations. Several of the fields are gently undulating, and soil erosion measures are essential. Roughly contoured silt pits and bunds with a leguminous cover had been established by the previous management, but it was felt that these would provide ideal harbourage for rats, and they were consequently smoothed out into wide bunds which could be planted with a crop. Some additional bunds were also constructed. For this purpose a four-furrow disc-plough was eventually obtained for all too short a time and proved admirably suited to the work. The average cost was 25 cents per chain.

Cultivation.

As the variety of implements was very limited it was not possible to vary the preliminary cultivation to any great extent. Generally speaking the land was given three cuts with a heavy, double-disc harrow over a

period of about a fortnight. The discs were set fully open and were drawn by a 'Caterpillar' D.4 track-tractor. The cost of cultivation varied from $9.72 to $13.46 per acre, averaging $12.13 which included fuel, oil and wages but not depreciation or supervision. These operations served to incorporate the cover in the soil except where heavy growth occurred in small hollows. A final cut with light discs fully closed was later given in an endeavour to compact the soil. At first this was done with a Fordson Major, but subsequently the light discs were attached behind the D.4 during the third cut. The D.4's gave little trouble, but could not be used for twenty-four hours after heavy rain.

Parts of the area were cultivated with R.4s, the petrol-driven counterpart of the D.4. The machines arrived in an unserviceable condition, and even after thorough overhauling were continually out of commission for repairs. In order to reduce costs they were adapted to run on a mixture of petrol and dieseline in the proportion of 1:4. The running costs worked out at $17.26 per acre, an unfavourable comparison with the D.4 which was $9.16 per acre for two heavy discings on the same field.

Drills.

The only seed drills available were of an Australian pattern delivering through 12 tubes at 7 ins. apart. After the clutch springs had been hardened and adjusted they worked very satisfactorily. No information could be found in the literature on the best seed rate or spacing for dry padi under mechanical conditions; this was therefore one of the chief factors to be investigated. It was thought that 7 ins. between rows would be too close, so the seed boxes were divided into compartments to effect delivery through alternate tubes at 14 ins. apart, and this was adopted as standard. For comparison an area of 10 acres on field No. 3 was sown at 7 ins. and the whole of field No. 1 at 21 ins.

Field No. 11 was the first to be drilled in ideal showery weather at the end of July. The machine was set at 22 lbs. (for barley) and actually delivered 17 lbs. per acre at a depth of one inch. The field had to be resown later because germination was very poor except in those drills which coincided with a tractor wheel track. This indicated that the seed bed was not sufficiently consolidated, and an attempt was made to obtain a Cambridge Roll. The only one in the country, however, was being used for wet padi trials which had priority. At this stage the light discs were brought into use and combined with chains behind the covering harrows. Slightly better packing of the soil was attained, but it was never as firm as could be wished. The chains, though valuable on a dry seed bed, soon clogged when the soil was at all moist on the surface and under these conditions were quite useless.

On field No. 2 the seed rate was increased to 56 lbs. per acre (setting) and the depth to 1½ ins. Later strips on this field were drilled at the settings of 67 and 80 lbs. respectively: actual deliveries were approximately

DRY PADI CULTIVATION AT SUNGEI BULOH, SELANGOR.

PLATE I.
A 4-furrow disc-plough building contour bunds.

PLATE II.
Seed drill sowing padi.

DRY PADI CULTIVATION AT SUNGEI BULOH, SELANGOR.

PLATE III.
Padi and gram sown in alternate drills.

PLATE IV.
A modified cultivator weeding dry padi.

half the set rates. Even the highest rate left bare patches where the soil was very soft, and it was felt that there was no object in adopting a higher setting than 80 lbs. on the manurial trials; the varietal trials were also sown at 80 lbs. The greater depth was found necessary in order to obtain a better covering of the seed, but some irregular patches in the fields were still not covered even though double covering harrows weighted with logs were used.

It was found that one drill of the type employed could cover an average of 8 acres per day when drawn by a Fordson Major. The average working cost was $3.16 per acre.

Manuring and Time of Planting.

Sowing was done on various dates between the 7th July and 3rd October, thus providing scope for observations on seasonal effects.

The standard fertiliser treatment adopted was 2 cwts. of F.P. No. 1 mixture per acre before sowing, 2 cwts. of F.P. No. 2 mixture after the first weeding, and 1 cwt. of superphosphate at completion of tillering. The mixtures analysed as follows:

	N.	P_2O_5.	K.
No. 1 ..	11 per cent.	8 per cent.	3 per cent.
No. 2 ..	5 ,,	13 ,,	4 ,,

On the varietal trials, however, bat guano with a phosphate content of 11 per cent. was used at the rate of 4 piculs (533 lbs.) per acre before sowing. All fertilisers were spread by hand.

On field No. 3, four 10-acre blocks were put down for comparative observations with the following treatments:

A. Bat guano at 533 lbs. per acre.

B. Control, no manure.

C. Standard mixtures.

D. Cowdung at 10 tons per acre.

At the time of writing plots C and D have made the most vigorous growth while A is better than B.

Varietal Trial.

A varietal trial using randomised duplicated plots of ½ acre each was sown on field No. 4; 23 varieties collected from all over the country are represented.

Of the main fields, Nos. 2 and 11 were sown with locally procured, somewhat mixed, seed and the plants have become affected with " blast " disease caused by the fungus *Piricularia oryzae*. No. 3 was sown with seed saved on Subang Government Farm last season where it yielded quite well. No. 1, the last to be sown, carried a reputed short term strain from Kelantan.

Weed Control.

Four observation blocks of 9 acres each were laid down on field No. 3 to give information on weed growth under the following different treatments:

A. Padi drilled at 14 ins. at 53 lbs. per acre (actual sowing rate).
B. A 2:1 mixture of padi and Bengal black gram at 7 ins. at 46 lbs. per acre.
C. Padi alone at 7 ins. and 80 lbs. per acre.
D. Padi and gram in alternate drills at 7 ins. (80 lbs. setting giving 40 lbs. rate).

In treatment D the gram rate was far too high at 41 lbs. per acre, but this could not be avoided if a sufficient stand of padi was to be obtained. In treatments A and C the few padi plants which managed to compete with weeds have been eaten by rats. An occasional patch of padi has managed to come through the gram, but the latter has made a fine cover and some plants began to flower at 7 weeks after sowing; this was unexpected as the same crop took 3 months to flower when planted at Subang earlier in the year.

It was hoped to weed the whole area by mechanical means, but the expected equipment did not arrive, and the only implement available was a rigid-tyne-mounted cultivator of a design not adapted to the drill spacing and made of very poor material. After many experiments, adjustments and major modifications, the implement was eventually brought into some sort of working order, but by this time the weeds had got a hold and fields Nos. 2 and 11 had to be given a first weeding by hand. The implement fitted with chisel point shoes was tried on parts of field No. 2 and the whole of No. 11 for the second weeding; it was drawn by a steel-wheeled Fordson Major intercrop tractor. The following disadvantages were recorded:

(a) The ground was so uneven that the depth of cultivation could not be set correctly.
(b) The implement swayed about and frequently uprooted the padi.
(c) The shoes kept working loose and tynes were continually being bent by sub-surface snags.
(d) Due to inexperienced operators on the drill, the padi rows were rather uneven, and this added to the cultivation difficulties.
(e) When working on contour slopes, the cultivator had a strong tendency to side-slip because its tractor attachment was too far from the body of the machine and therefore gave the operator little or no direct control over it. It is considered that for any work of this nature, the implement must be close-coupled under the stern of the tractor.
(f) The Fordson was difficult to steer between the twisting contour rows and, especially on the turn, the wheels skidded and destroyed the crop.
(g) The weeds growing in the lines of padi were not affected, and in many places are swamping the crop.

In view of this experience the varietal and manuring trials are being hand weeded.

A Mark II cultivator was subsequently designed from a second Mark I. Locally made spring loaded tynes were fitted, and the body was broken down and rewelded to give a much closer attachment to the tractor. This implement was used with some success on the wider spaced rows in field No. 1, and was followed up by hand labour to remove the weeds which had not been touched by it. Complete costs of such combined operations are not yet available, but they are known to be very high.

It is thought that disadvantage (g) above cannot be overcome by any type of implement; the weed problem is therefore one of management, and in future no attempt should be made to grow dry padi by mechanical means unless the land is known to be clean. The fallow weeding already described on field No. 4 may provide an answer as this field is undoubtedly giving less trouble than the others, but on general principles it is not desirable to leave land under a bare fallow in this climate. It is possible that a better solution might be found by growing a crop of *Calopogonium* to smother weed growth and turning it in before it seeds; information on this point should be obtainable from field No. 12 now being sown to groundnuts.

Conclusions.

This is an interim account and no definite conclusions can yet be drawn from the work except that it is possible to prepare the land and drill dry padi at a reasonable cost by mechanical means.

Summary.

An account is given of the costs and difficulties encountered in growing dry padi by mechanical means.

Experiments undertaken are briefly described.

INVESTIGATIONS INTO MECHANICAL STUMPING AND CULTIVATION OF DRY PADI ON FELLED RUBBER LAND

BY

H. J. SIMPSON,

Agricultural Officer, Penang and Province Wellesley,

AND

T. A. KENDALL,

Food Production Officer, Bertam.

Introduction.

During the Japanese occupation of Malaya a considerable acreage of old rubber was felled in order to provide land for the cultivation of food crops. The Short Term Food Production organisation took over many of these areas as Government Farms and when the organisation was absorbed by the Department of Agriculture, it was decided for the purpose of investigation to clear mechanically an area of 120 acres on Bertam Estate and cultivate a crop of dry padi during the normal season, September to February. The rubber had been felled by the Japanese in 1943, but the land had never been cultivated, so that by February 1947, it was covered with a thick growth of lalang, *belukar* and grasses. The stumps of the rubber trees, which had been felled at a height of some 3 ft., were still firm and undecayed. The soil on the area chosen is a heavy coastal clay with a mixture of peat which makes it fairly easy to work when dry but tends to become very sticky after rain. The area actually worked was divided into blocks, varying in size from 2½ to 10 acres and completely isolated from one another by deep and wide drains.

Stumping.

In order to allow full use to be made of cultivation implements, the land had to be stumped and the stumps heaped and burnt or removed to the edge of the field for disposal. The first attempt at stumping was made using a D.4 fitted with a bulldozer, but this was abandoned after two days' trial as it was too heavy work for the machine. However, some 40 stumps were removed at an approximate running cost of 80 cents per stump.

On the arrival of the heavy equipment, which consisted of 2 D.8 bulldozers, a further attempt was made. The bulldozer is, of course, designed essentially for earth moving and is ill-equipped for the specialised operation of stumping, which may be carried out with less soil disturbance by means of a 'stumper' attached to a similar tractor; at this period, however, none was available in this country. The best day's work accounted for 10 acres and stumped some 700 stumps, at a cost of approximately $20, or

DRY PADI CULTIVATION AT BERTAM GOVERNMENT FARM, PROVINCE WELLESLEY.

PLATE I.
'Caterpillar' D. 8 Bulldozer felling a rubber tree.

PLATE II.
The Bulldozer completing the operation.

DRY PADI CULTIVATION AT BERTAM GOVERNMENT FARM,
PROVINCE WELLESLEY.

PLATE III.

The land after being cultivated by a disc-plough followed by a heavy disc-harrow.

PLATE IV.

The same area after a third cultivation, mainly by a light disc-harrow.

$2 per acre and 2.86 cents per stump. Although 10 acres per day is above average it is considered that the maximum figure could be higher as the 10 acre block referred to is bounded on four sides by field drains which limited the field of action. The D.8 requires plenty of room to manoeuvre, and stumps along drain sides are in a position which makes it difficult for the large machine to be used efficiently. However, owing to mechanical breakdowns and wet weather, the average cost of stumping worked out very considerably higher, at $15 to $20 per acre.

To remove the ordinary rubber stump required two individual operations. First a direct push at the highest point of the stumps which is able to bear the full impact of the D.8; this pushes the stump to an angle of 45°, after which the dozer is inserted under the now exposed roots and completes the operation by pushing the stump clean out of the ground. Stumps over 60 ins. in circumference at 3 ft. from the ground generally require many more operations before the stump is finally extracted. For instance, in removing a stump whose circumference was 7 ft. at 42 ins. from the ground (where it had previously been cut) required no less than 12 operations. The first was to cut out the lateral roots from the left side of the stump, this took three successive digs by the dozer and finished up with a sloping cut, the centre of which was 2 ft. below ground level and which succeeded in cutting one lateral root of 39 ins. in circumference. A similar operation, each requiring three cuts, was then carried out on the opposite side and on the front face. Finally two direct pushes near the top of the stump and one under the roots completed removal of the tree. The two stages in the removal of a rubber tree may be seen in Plates I and II; in many ways a stump is more difficult to remove as less leverage can be used.

Heaping.

After removal and in order to have a clear run for cultivation operations, the stumps were disposed of by heaping and, where the time and weather allowed, by subsequent burning. The work of heaping was carried out with the aid of D.4's, partly by towing and partly by dozing the stumps into a heap. The cost of this work ranged from $3.45 per acre under fair conditions up to as high as $30 per acre when mechanical breakdowns occurred, a single machine clearing on an average 2 acres per day. The chief source of trouble was broken wire ropes; wire ropes of at least I in. diameter are recommended for this type of work.

Rooting and Eradication of Lalang.

After the ground had been cleared of stumps a first ploughing was attempted, but the only ploughs available at the time were 2 double-furrow mould-board ploughs. These proved quite unequal to the strain and repeatedly buckled on coming in contact with old roots. Such roots as tembusu (*Fagraea cochinchinensis*), which apparently had failed to decompose even after very many years below ground, were especially troublesome. Plough-

ing costs with the mould-board plough over a period of some months worked out at $31.77 per acre, the high cost being due to breakdowns and wet weather.

To overcome the difficulty caused by the roots, a heavy 'rooter' was borrowed for a very short period and this implement proved most effective, damage to ploughs and harrows being completely eliminated. A D.4 was used to pull the machine, and an area of some 10 acres was completed in 2 days at a cost of $3.20 per acre. Unfortunately the rooter had to be returned at the end of that period but by that time it had proved its value. Although the D.4 did the job effectively, it was heavy work and it would probably have been done just as economically and with less strain to the machine by a D.6 or D.7. It is considered essential that the roots be removed in some way before the use of normal agricultural implements and a 'rooter' was shown to be efficient for the purpose. An alternative may be a 'root-rake' which consists of a series of strong teeth attached to the side arms in place of a bulldozer, and it is hoped to make a trial with one in the near future.

A Ransome's 'Dragoon' TD.3, a 5-disc plough, was next tried. Although this had been lying idle during the Japanese occupation and had deteriorated to such an extent that only four discs could be used, it did good work and proved a success. In a very short trial 10 acres were ploughed during the course of one day using a D.4 as motive power, the cost per acre being $1.60.

The third type of plough to be tried was a new, Australian built, 4-disc plough. Although new, the implement proved disappointing as the castings holding the discs broke as soon as the plough encountered hard soil or obstacles. New castings made of bronze were made locally and these have proved fairly satisfactory. The plough, however, is too fragile for such a heavy power unit as a D.4 but can be used with some degree of safety with a wheeled tractor such as a Fordson Major, but in the latter case the power is insufficient when the land is at all sticky or hard and only three discs can be used.

By far the most successful implement used for the eradication of lalang was a heavy double-banked disc-harrow with 22 discs. Although the only implement available was minus 7 discs, excellent work was done, equal to any of the ploughing carried out. On a good day, drawn by a D.4, 10 acres were cultivated at a cost of $1.60 per acre. As in the case of ploughing, the size of the field is a limiting factor; if longer runs had been obtainable, far larger acreages would have been accomplished. The average worked out at 6 acres per day with a cost of $2.66 per acre. It should not, however, be assumed that ploughing is not essential. It is recommended that a good disc-plough which turns the soil completely over and exposes the roots of the lalang, followed by the heavy disc-harrow is the ideal combination and the result may be seen in Plate III.

DRY PADI CULTIVATION AT BERTAM GOVERNMENT FARM, PROVINCE WELLESLEY.

PLATE V.
The disc drill being drawn by a 'Standard Fordson.'

PLATE VI.
Dry padi sown with a drill.

Subsequent to the ploughing and heavy disc-harrowing, a light disc-harrow was used (Plate IV). Two light four-banked disc-harrows in a poor state of repair were available and succeeded in doing some very good work although, at this period of their life, breakdowns were frequent. In spite of proper care and systematic greasing, the shafts were constantly jamming and the nuts and bolts, very thread-worn, had to be constantly replaced, while discs, also, had to be repaired by welding on several occasions. Both D.4's and Fordson Majors were used as the traction power for these harrows. The running costs of the Fordson are slightly higher than those of a D. 4 but work is, on the other hand, definitely quicker, a maximum of 10 acres being completed in one day with the former as compared with 6 acres for the latter.

As the result of the poor mechanical condition of these implements a second harrowing was necessary. It is however considered that with a new machine one harrowing would have been sufficient in the dry weather conditions such as obtained during the course of these trials. The former 'sheet' lalang had ceased to exist after an initial ploughing and one harrowing with a heavy disc-harrow followed by two runs of the light disc-harrow. In good weather conditions eradication of lalang can, therefore, be carried out by this method at a cost of $15 to $20 per acre, provided the equipment is well maintained.

Seeding.

Planting was commenced on the 17th August, a seed drill drawn by a Fordson Major being used (Plate V). This machine, although primarily meant for wheat, barley etc., was, with minor adjustments, found to be well suited to the sowing of padi seed. As the drills were obviously too close together for the sowing of padi, every alternate drill was cut off by closing the holes through which the seeds drop, to give a planting distance of 14 ins. between the rows (Plate VI). The gearing was then tested in various positions and was finally set to plant seven seeds per linear foot, giving a seed rate of approximately 17½ lbs. per acre, which has proved to be extremely satisfactory. The rate of planting under good conditions was 15 acres per day and cost $1.20 per acre, a more normal figure was, however, 10 acres per day at $1.80 per acre.

Owing to the lack of suitable equipment all subsequent cultivation, such as weeding and top dressing with manure, had to be done by hand.

Manuring.

Manuring was carried out as follows:—

First round prior to planting at the rate of 4 cwts. of F.P. No. 1 mixture per acre.

Second round, three weeks after planting, at the rate of 70 lbs. F.P. No. 2 mixture per acre.

The only exception was in the case of Plot No. 1 where an addition of 1 ton of compost per acre was broadcast before planting.

Growth of Dry Padi.

Compared with adjacent blocks, which have been cultivated and planted by hand, the padi in the experimental area has grown more evenly and is more promising. At the time of writing the padi is ripening and a good crop, estimated at over 200 gantangs per acre in the best blocks, is expected. This is satisfactory on the whole in view of the rather poor weather that has been experienced. The area was flooded on two occasions in October and again in November, and between times little or no rain fell. Rainfall figures were: September 16.75 ins., October 24.18 ins., with a heavy rainfall of 8.17 ins. on the 29th night, and November, 5.97 ins.

Conclusions.

It is not possible at this stage to draw any definite conclusions from the above trials with regard to the economics of growing dry padi by mechanical methods, but it has been shown that, with suitable mechanical equipment, stumping and clearing of old rubber land can be done cheaply and more efficiently than by the usual hand methods.

Summary.

An account is given of the costs and difficulties encountered in stumping, lalang eradication and preparing old rubber land for growing dry padi by mechanical means.

NOTES ON MECHANICAL CULTIVATION COSTS AT THE CENTRAL EXPERIMENT STATION, SERDANG

BY

C. W. S. HARTLEY,

Agricultural Officer-in-charge, Central Experiment Station, Serdang.

In May 1947, Fordson tractors and D.4 and R.4 'Caterpillar' tractors became available at the Central Experiment Station for assisting in the work of rehabilitation rendered necessary on account of neglect during the Japanese occupation. The tractor implements which became available during the year were:

Ploughs: 4-furrow disc-plough (Robinson's Royal), Breadth of cut 30 ins.
3-furrow disc-plough (International Harvesters), Breadth of cut 24 ins.
2-furrow mould-board plough (Ransomes), Breadth of cut 24 ins.
1-furrow 'Prairie buster' mould-board plough, Breadth of cut 18 ins.

Disc-harrows—Heavy Breadth of cut 90 ins.
Light " " 96 ins.
Spring-tyne cultivator " " 76 ins.

During June, July and August various combinations of tractors and implements were tried out both on flat land on quartzite valley soil and between oil palms on quartzite hill soil. Much useful information was obtained on the most suitable combinations to use under varying conditions, and preliminary figures obtained gave a good indication of operation costs.

The figures given in these notes refer to trials of certain combinations of tractors and implements carried out during September, October and November. September and early October were exceptionally dry for the time of year and easy conditions for mechanical cultivation were the rule. In late October and early November, however, wetter conditions were experienced.

It is necessary to point out that the information given is only intended to indicate the work that can be done by the combinations tried, and so give the reader practical information on operations and costs under conditions prevailing at Serdang. The ultimate agricultural effect of the operations described lies outside the scope of these notes and, in particular, the best mechanical method of lalang eradication remains to be determined. Some useful ideas on lalang eradication have necessarily been obtained during the course of this work, and at present it seems that deep mould-board ploughing in dry weather followed by discing and, perhaps, dragging up

roots with spring-tyne cultivators is likely to be superior at Serdang to disc ploughing. No definite recommendations can, however, be made until results are obtained from trials on lalang eradication which are now in hand.

Tractors.

The Standard Fordson is a wheel tractor with 36 h.p. engine designed to run on power kerosene but requiring a small quantity of petrol for starting up. Steel-rim rear wheels were used with 5 in. cleats. The width of the rims is 9 ins.. For all the cultivations described, except one, the tractor was run on a mixture of 4 parts kerosene to 1 part of diesel oil. This has given reasonably satisfactory running but the mixture has not been sufficiently tried out locally, and a general recommendation as to its suitability cannot yet be made.

The 'Caterpillar' D.4 is a track-tractor with 35 to 68 h.p. engine running on diesel oil. The track is 13 ins. wide with 2 in. lugs set 7 ins. apart. This tractor has bulldozer equipment which should however be removed to lighten the load when ordinary agricultural operations are being carried out.

The 'Caterpillar' R.4 is a track-tractor similar in all respects to the D. 4 except that it has a 36 h.p. engine running on petrol or " tractor fuel " (kerosene or other spark ignition engine fuels which vaporise less readily than petrol). For the cultivations described the R. 4 was started on petrol and then run on kerosene.

Operators and Labour.

The method at present employed at Serdang is to allot a tractor to a trained operator who is then responsible for its care and maintenance and for the cleaning of any implements he is using, but not for carrying out any repairs required. The operator should be actually ploughing or carrying out any other cultivation for a minimum of 6½ hours each day provided no breakdown occurs. Up to half-an-hour is allowed for checking over the tractor, starting up and moving to the part of the field where cultivation is to begin. Half an hour is allotted to the cleaning and maintenance of tractor and implement at the end of the day and up to half an hour is permitted at some time in the middle or at the end of operation for a 'rest' during which food and drink is taken and nuts and bolts checked over. A labourer is allotted to assist each operator so as to minimise delays if the implement becomes clogged or if the tractor gets into difficulties in a soft patch of ground.

This system may be criticised on the grounds that insufficient actual hours of work are being obtained from the tractor each day and it is worth noting that on an estate in Perak, where ploughing with a Fordson tractor has recently been carried out, the tractor is kept in operation from 7 a.m. to 5 p.m., i.e., 10 hours, and three operators are employed, of whom two are always on duty. Each man therefore drives for 3¼ hours and accompanies the tractor for another 3¼ hours (apart from his work of tractor and

implement maintenance). The actual amount of tractor operation work obtained per day from two men is therefore about the same on the estate as at Serdang.

Labour costs are calculated from the new Government rates for Class II operators and for daily paid labourers, i.e., $3.64 per day and $1.64 per day respectively.

In the figures given in Table I acreage covered and costs are calculated per hour of operation. These figures are then converted to acres and costs per day by multiplying by 6½. The actual number of hours of operation were not, owing to minor break-downs etc., invariably 6½, and certain cultivations were of course begun and finished in the middle of a day's work. Breakdowns are due to a variety of factors such as the age and condition of tractor or implement, the skill and experience of operators etc. Interruptions also occur owing to heavy rain. It is clearly of more value to the reader therefore to have the results presented on a basis of hours of operation. No depreciation figures have been introduced into these costs. Lubricating oil costs have been calculated on a basis of 0.6 pints per running hour for the Fordson and 0.8 pints for the D.4 and R.4, which includes allowance for refilling the sump every 60 hours.

Cultivation.

The acreage covered in the cultivation to be described, together with fuel consumption and costs, are summarised in the table.

I. *Ploughing with 4-furrow disc-plough and Fordson tractor.* The area covered in the example given in the table was 16.5 acres of flat valley quartzite clay loam. Ploughing was carried out in late September during a period of dry weather. The land was under a re-growth of light lalang following light disc-harrowing earlier in the year. The depth of ploughing was 5 to 6 ins.

II. *Light disc harrowing with Fordson tractor.* The area covered was 20.7 acres of flat valley quartzite clay loam previously ploughed with 4-furrow disc-plough and 2-furrow mould-board plough. The harrow used, the only one available at the time, was, in spite of weighting, too light for breaking down the furrows and the land was actually covered five times before a level tilth was obtained. The cultivation was therefore expensive and a heavy harrow would have been more economical. The method used was to take half a harrow's width again at each round so that two harrowings of the land were obtained each time the Fordson had 'completed' the field. This was repeated across the field and followed by a single harrowing up and down the field, giving five cultivations in all. The cost of a single light harrowing can therefore be calculated from the table to be $1.19 per acre.

III. *'Prairie Buster' single-furrow plough with 'Caterpillar' D.4 tractor.* This is an exceptionally strong mould-board plough capable of working to a great depth and uprooting tree roots remaining in the ground after

TABLE I.

Running Costs of some Mechanical Cultivations.

Central Experiment Station, Serdang.

September-November, 1947.

No.	OPERATION	Acres	Time (Hours)	Time Calculated (Days)	Time Actual (Days)	Acres per Hour	Acres per Day	Fuel Consumption				Total Cost	Labour Total Cost Calculated	Total Running Costs	Total Running Costs per hour	Total Running Costs per acre
								Petrol (gallons)	Kerosene (gallons)	Diesel (gallons)	Lubricants (gallons)					
												$ c.	$ c.	$ c.	$ c.	$ c.
I.	Four-furrow disc-plough and Fordson tractor ..	16.5	41	6.3	7	.40	2.6	4	56	13	3	69.43	33.21	102.64	2.51	6.22
II.	Light disc-harrow and Fordson tractor (5 times) ..	20.7	48	7.4	8	.43	2.8	4½	68	17	3½	83.95	38.88	122.83	2.56	5.93
III.	'Prairie buster' single furrow mould-board plough and 'Caterpillar' D.4 track-tractor	6.5	25	3.8	5	.26	1.7	1½	—	40	2½	28.40	20.25	48.65	1.95	7.48
IV.	Three-furrow disc-plough and D.4 with bulldozer for 'belukar' ploughing ..	5.7	28	4.3	5	.20	1.3	2½	—	34	2½	27.38	29.68	57.06	2.04	10.19
V.	Heavy disc-harrow & D.4 (twice)	5.7	10	1.5	2	.57	3.7	1	—	14	1	10.98	8.10	19.08	1.91	3.35
VI.	Spring-tyne harrow and Fordson (twice) ..	5.7	10½	1.6	2	.54	3.5	1½	14	4	¾	18.41	10.93	29.34	2.79	5.15
VII.	Two-furrow digger mould-board plough with Fordson ..	1.8	15	2.3	3	.12	0.8	2½	24	5	½	28.23	15.90	44.13	2.94	24.52
VIII.	Filling in silt pits with D.4 and bulldozer ..	8.0†	26	4.0	4	.31	1.9	2	—	40	2½	29.10	21.06	50.16	1.93	6.27
IX.	Inter-row cultivation of oil palms. Four-furrow disc-plough with R. 4 ..	5.1*	13½	2.1	3	.38	2.5	1¾	19	—	1¼	22.73	10.93	33.66	2.49	6.60
	With D.4 (estimated)	—	—	—	—	—	—	¾	—	16	1¼	12.32	—	23.25	1.72	4.56
X.	Two-furrow mounld-board plough with R. 4 ..	1.9*	9	1.4	2	.21	1.4	1	12	—	1	14.84	7.29	22.13	2.46	11.65
	With D.4 (estimated)	—	—	—	—	—	—	½	—	11	1	8.87	—	16.16	1.79	8.51
XI.	Light disc-harrow with Fordson (twice) ..	7.8*	8	1.2	3	.98	6.4	1½	14	—	½	15.78	6.48	22.26	2.78	2.85

† in all 98.9 chains, i.e., 12.4 chains per acre.

* ft. strip in the palm rows remained unploughed, i.e., 3/13th of the area.

MECHANICAL CULTIVATION AT THE CENTRAL EXPERIMENT STATION, SERDANG.

PLATE I.
The 'Prairie-buster' Plough.

PLATE II.
Ploughing with a 3-furrow disc-plough in *belukar* (secondary jungle growth).

MECHANICAL CULTIVATION AT THE CENTRAL EXPERIMENT STATION. SERDANG.

PLATE III.
The ploughed *belukar*.

PLATE IV.
'Caterpillar' D. 4 with heavy disc-harrows.

felling. The area recorded here was an old pasture consisting of mixed carpet grass and lalang. One third of the area was flat land with a fairly heavy clay soil and the remainder was sloping ground on Raub series soil of a very friable texture. The latter was ploughed on the contour. The depth of ploughing was 12 to 14 ins. (Plate I).

IV. *Three-furrow disc-plough with 'Caterpillar' D.4 track-tractor with bulldozer equipment. Ploughing in belukar.* This was an area of dark, valley quartzite soil covered with scrub (chiefly melastoma) some 6 to 8 ft. high with an undergrowth of carpet grass and lalang. The bulldozer was set at about 6 ins. above ground level and thus flattened the scrub in its passage over the ground. The 3-furrow disc-plough then turned over the soil together with the flattened vegetation. Woody melastoma stems often became entangled in the plough and this accounted for the comparatively slow work. Nevertheless 1¼ acres per day under these conditions must be considered satisfactory (Plates II and III). Comparatively dry conditions prevailed throughout this cultivation. Two labourers were employed to assist.

V. *Heavy disc-harrow with 'Caterpillar' D.4 track-tractor.* This heavy disc-harrowing followed a fortnight after the 3-furrow disc-ploughing and after a few days of rain. In spite of woody melastoma stems impeding progress from time to time a reasonably level tilth was obtained with two discings on the 5.7 acres in 1½ days work (Plate IV).

VI. *Spring-tyne cultivator with Fordson.* This cultivation was carried out on the same land as IV and V (after a further disc harrowing) with the object of bringing the chopped lalang roots to the surface. The operation was carried out twice, firstly at a depth of 1 to 2 ins. for gathering up roots and other debris on the surface and secondly a cross cultivation at a depth of about 4 ins. The operation is shown in Plate V. Two labourers were employed to assist.

VII. *Two-furrow, digger type, mould-board plough with Fordson.* The cultivation was carried out on an area of heavy lalang mixed with *Eupatorium odoratum, Mikania scandens* and other creepers. Ploughing was fairly deep (8 to 10 ins.). The soil in this area was a yellow clay loam. The plough often became clogged with vegetation which accounts for the slow rate of progress. It was estimated that, had ploughing proceeded without interruption, over 3 acres per day could have been ploughed, and this acreage may be expected with this plough on areas of lighter growth. Two labourers were employed.

Inter-row Cultivation of Oil Palms.

Most of the oil palm areas at Serdang are on sloping land and the palms are planted 30 x 30 ft. triangular. Ploughing and cross ploughing therefore means that, in one or both of these ploughings, cultivation will be up and down a slope and soil erosion may follow. The ploughing recorded in the table was done on an area where the palm rows, in one direction, followed the hill contour almost exactly. Ploughing was only done between

these rows leaving a strip unploughed along the rows between trees to act as a barrier against erosion. The area had previously been provided with silt pits so that the cultivations to be carried out were (1) filling in silt pits with D.4 and bulldozer, (2) ploughing and (3) harrowing.

VIII. *Filling in silt pits with D.4 and bulldozer.* This operation is illustrated in Plate VI where an R.4 is being used for the same purpose. The table shows that 98.9 chains covering an area of 8 acres were filled in 4 days. The operation was completed by running one track of the D.4 along the line of the silt pits to consolidate the filled earth in the pits and provide an even surface for ploughing.

IX and X. *Ploughing with 4-disc plough, and 2-furrow mould-board plough.* The method of ploughing was to take a row of trees and plough to and fro in the avenues on either side of the row, turning at the ends in a clockwise direction until the rows on either side were reached. The plough then moved to the next pair of avenues. By this method there is some difficulty in getting round at the end of the row when starting to plough and an easier method whereby alternate avenues are taken has been devised. When ploughing with disc-ploughs along the contour with the downward slope on the left hand side there was a continual tendency for the plough to slide out to the left, and uneven and shallow ploughing resulted in half the avenues thus ploughed. The mould-board plough was found generally more satisfactory for this work. The soil was a friable, hill-quartzite, yellow-clay loam and it was found that a Fordson could not manage the work satisfactorily with either of these ploughs. On the sloping land the lower rear wheel tended to dig into the loose soil and the work was continually held up.

XI. *Light disc-harrowing with Fordson tractor.* This operation followed disc and mould-board ploughing between oil palms. The harrow covered the ground twice by taking half a harrow's width again at each round.

Discussion.

Examination of the table reveals that work has been generally rather slower than with the same tractor and implement combinations in Europe or America, even when operating on flat land. This may be attributed to a number of factors. Firstly, many tropical soils tend to be friable and loose for some considerable depth and often have no firm layer such as is found as a 'plough pan' in cultivated soils of Europe and America or in some of the padi fields of north Malaya. If the work becomes heavy or any obstruction is met with, therefore, there is a tendency, particularly with wheel tractors, for wheel or track slip to take place and for the tractor to dig itself further and further into the ground owing to the absence of a firm bottom. A good operator will of course stop and remove or reduce the cause of obstruction before this 'digging in' occurs.

Secondly, areas to be ploughed in Malaya often carry a heavy growth

MECHANICAL CULTIVATION AT THE CENTRAL EXPERIMENT STATION, SERDANG.

PLATE V.
Spring-tyne cultivator in a lalang area.

PLATE VI.
'Caterpillar' R. 4 filling silt-pits.

of vegetation. This vegetation normally contains twining plants such as *Mikania scandens*. Particularly in the case of mould-board ploughing, this vegetation tends to accumulate on the plough and eventually forms a tight ball, between the mould-boards or discs and the beams, which has to be cleared before the plough can proceed. Mould-board ploughing, as is well known, gives much neater work and turns in the vegetation more thoroughly than does disc ploughing, but in rough ground with rank vegetation it is advisable to precede mould-board ploughing by shallow, disc ploughing or by disc harrowing. The slow rate of work and expense of cultivation (VII) bears this out.

Thirdly, tractor cultivation in open land in the tropics is much more arduous and difficult for the operator than in temperate regions owing to the heat and the unevenness of ground surface.

With the rougher conditions prevailing, it is thought that wear and tear will be greater than in Europe and that depreciation of tractors and implements will be more rapid.

Summary.

1. Working costs are given for cultivations carried out at the Central Experiment Station, Serdang, with disc and mould-board ploughs, disc-harrows and spring-tyne cultivators on flat, valley quartzite soils and sloping, hill quartzite and Raub series soils, using Fordson and 'Caterpillar' D.4 and R.4 track-tractors.

2. Costs are also given for filling in silt pits with 'Caterpillar' D.4 and bulldozer on hill quartzite soil.

3. Difficulties experienced during cultivation and the relative value of different implements are discussed.

Acknowledgement.

Acknowledgement is made to Mr. H. J. Simpson, formerly Agricultural Officer-in-charge, Central Experiment Station, Serdang, who started the records at Serdang, to Che Ismail bin Abu Bakar, who did most of the recording, and to other members of the staff at the Central Experiment Station who assisted both in the field and in discussion.

ROTARY HOE TRIALS AT THE COLLEGE OF AGRICULTURE, SERDANG

BY

V. DAWSON,

Principal, College of Agriculture, Malaya.

A 20 in. Howard " Gem " Rotary Hoe has now been in use at the College for about 2 months and a certain amount of experience has been gained by the students as to its utility and capacity for performing some types of the work encountered in this area, which in the main consists of fairly heavy soils of the valley quartzite type.

Cultivation of Land Under Dense Sheet Lalang.

Attempts were made to bring an area of this description into cultivation by using the machine alone, i.e., no preliminary slashing or cultivation. These were unsuccessful because the machine pushed down the tall lalang in front of itself and then tended to lift clear as the revolving blades came down on the tough lalang mat; also the blades very quickly became bound and choked with lalang. It is therefore fairly certain that the machine as supplied will not " walk " into dense sheet lalang. When opportunity permits, it is intended to try the effect of slashing and removing the cut lalang and slashing and withering the cut lalang *in situ* as preliminaries to machine cultivation.

Cultivation of Land Under Grass and Light Lalang.

A piece of flat land was selected which had been under grass for 14 years. This was well-compacted and contained a considerable proportion of evenly distributed lalang up to about 18 ins. high. (Plates I and II). No difficulty was experienced in this case in obtaining, after four runs, an area of soil well-cultivated to a depth of 5 ins. measured against the untreated surface.

Capacity.

The machine cuts 20 ins. wide and, apart from the first scarifying run which was made in 2nd gear, the remaining three runs were all made in bottom gear. The data obtained, corrected to a 1 acre basis, were as follows:—

Run No.	Work	Depth	Time per Acre	
			Average	Minimum
(1)	Scarification	± 1 in.	5 h. 14 m.	3 h. 34 m.
(2)	Cultivation	± 3 ins.	6 h. 32 m.	5 h. 13 m.
(3)	,,	± 4 ins.	7 h. 28 m.	5 h. 20 m.
(4)	,,	± 5 ins.	7 h. 28 m.	5 h. 20 m.
			26 h. 42 m.	19 h. 27 m.

ROTARY HOE TRIALS AT THE COLLEGE OF AGRICULTURE, SERDANG.

PLATE I.
A student operating the machine.

PLATE II.
The experimental area.

The average figures indicate what might reasonably be expected from a moderately skilled operator and were calculated from the actual times taken to cultivate 1/20th acre. The minimum figures represent the theoretical maximum capacity of the machine and make no allowances for time lost in turning, losses caused by over-running the cultivated portions, and so on. In practice, particularly where the operators are not skilled, it is difficult, during the third and fourth runs, to avoid some wandering back on to the adjoining cut that has already been cultivated, with consequent loss of time due to over-cultivation.

General.

This machine has been found a most useful and reliable aid to vegetable and fruit cultivation at the College. It has very greatly reduced the changkolling otherwise required and has accordingly permitted considerable expansion of the food-crop areas. It performs the work for which it was designed, chiefly weed control, pulverisation and thorough, even, incorporation of surface organic matter, very well indeed, leaving the soil ready to be thrown up into beds. Petrol consumption averages about 1 gallon per 2½ hours of actual work, oil consumption being negligible apart from the complete change of engine oil after each 24 working hours (2½ pints).

BUND CONSTRUCTION BY BULLDOZERS AT KRUBONG, MALACCA

BY

G. E. EGAN,

Drainage and Irrigation Engineer, Malacca.

The Krubong area is located on the right bank of the Malacca River opposite Durian Tunggal. It is about two miles long and averages nearly half a mile in width. The area of existing and potential *sawah* amounts to 400 acres, but recurrent damage to crops caused by frequent flooding from the Malacca River has gradually discouraged cultivation and less than 10 per cent. of the land was planted last year.

The area adjoins a portion of the Malacca River which was dredged in 1939 as part of a scheme for improving drainage in the Malacca River Valley by enlarging and deepening the channel from Durian Tunggal to the sea. The progress of the scheme was interrupted by the Japanese invasion of Malaya, but the dredging of the river at Krubong had been completed, the spoil being dumped on either bank of the river. The dredging was carried out by a 21 RB excavator mounted on a pontoon. The width of the Malacca River in the vicinity averages 60 ft., and the pontoon travelled close to one bank, dredging half the width of the river at a time and depositing spoil as far as possible from the bank of the river. The length of the jib was 60 ft., and the dredgings, which were a mixture of sand and clay and a large quantity of water, were dumped in the form of a low bank the dimensions of which varied considerably but which averaged about 2 ft. in depth and 30 ft. in width. The edge of the spoil bank was generally about 15 ft. from the river (Plate I).

The size of the bank is reasonably uniform in straight stretches of the river but is greatly reduced on the outer curves of bends where the river tends to maintain a deep channel. The ground on either bank of the river is also swampy in places and the dredgings tended to sink into it over a period of years so that their limits were eventually no longer well defined.

When Government funds and plant became available in March, 1947 for increasing the acreage under rice cultivation the protection of the Krubong area from periodic flooding by the Malacca River came up for consideration, and it was decided that the spoil bank skirting the river could readily be formed into a bund by means of bulldozers to protect the area. Two D.4 machines were chosen for the work, in preference to the larger D.8's, as they were more manoeuvrable and less likely to get bogged in soft ground. One of the bulldozers was fitted with a "Hyster" winch which proved to be very useful, particularly after heavy rains when

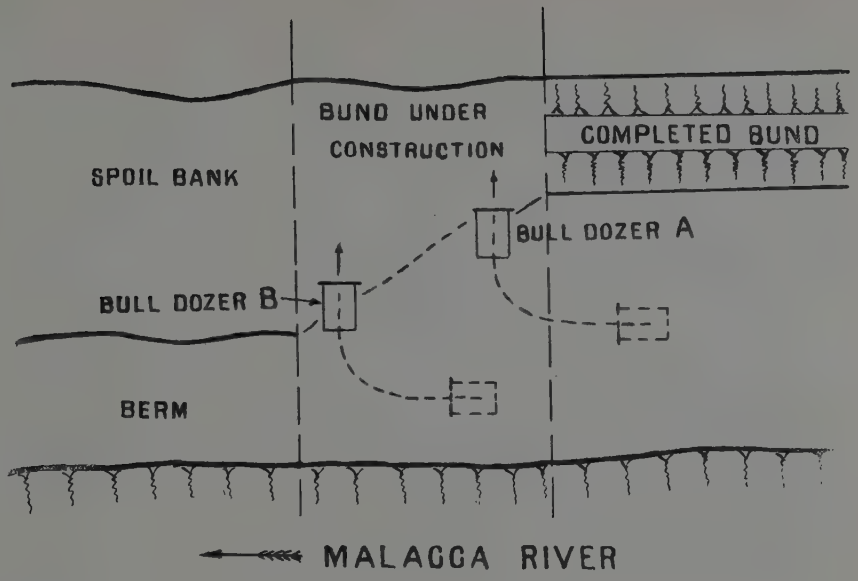

FIGURE I.

Bulldozers A and B working in parallel. Progress rapid, consolidation poor.

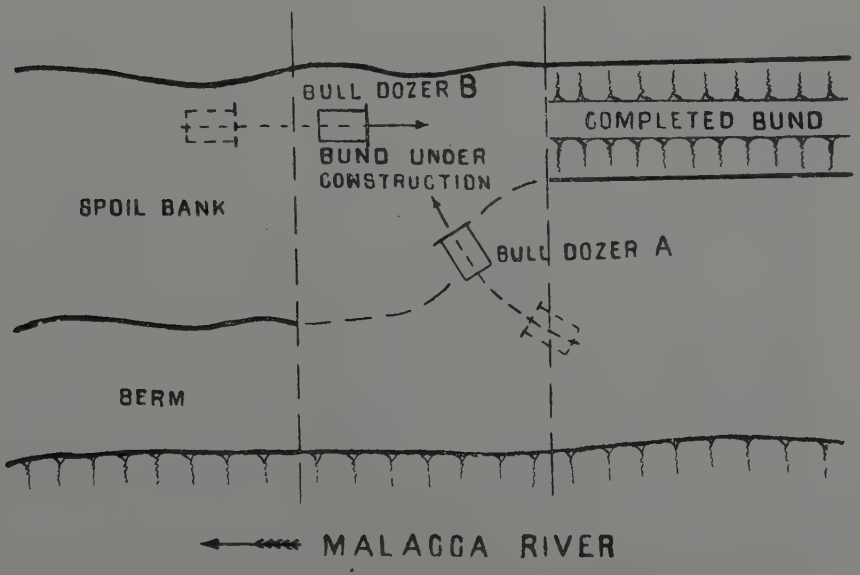

FIGURE II.

Bulldozer A feeds spoil to B which travels forwards and backwards on bund. Progress slower, but consolidation very good.

PLATE I.

The Malacca River, showing on the far bank, the completed bund. On the near bank the spoil bank may be seen.

PLATE II.

'Caterpillar' D. 4's constructing the bund.

one or other of the bulldozers occasionally bogged down. Both bulldozers could, with advantage, have been equipped with winches. Alternatively, a monkey grubber should be kept at the working site.

The bulldozers started work at the upstream end of the area towards the end of May. Each machine worked two shifts daily, and the crew consisted of one driver and two labourers per machine, per shift. A fitter was engaged for the maintenance of both machines. A gang of sixteen men, working one shift, trimmed and spot turfed the newly formed bund.

Working conditions were almost ideal at the start as the weather was dry and the spoil bank was hard and wide and more than adequate in volume for the formation of the bund. The bulldozers worked as far as possible from the river towards the *sawah* and pushed the spoil up into a bund along the edge of the spoil bank adjoining the *sawah*. Both bulldozers worked in parallel directions a short distance from one another. (See Fig. 1). It was found, however, that this method resulted in poor consolidation as the bulldozers did not travel to and fro on the newly formed bund. This method was therefore abandoned in favour of that shown in Fig. 2 where bulldozer "A" piled the spoil from the outer portion of the spoil bank in front of the blade of bulldozer "B" which then pushed it into place in the bund, travelling forwards and backwards in a longitudinal direction on the bund while doing so. It was found that bulldozer "A" could pile up spoil to a height of 4 ft. above its track level, while "B" consolidated the fill to within 1 ft. of finished bund level. Further consolidation was considered impracticable on account of the time involved and the fact that the bund had to be completed, as far as possible, during the dry season.

The methods described above could only be used where the volume of the spoil bank exceeded that required for the formation of the bund, and the bank was well removed from the edge of the river. Where the volume of spoil was insufficient, and the edge of the spoil bank was close to the river, a shallow borrow pit was formed inside the bund, and bulldozer "A" worked from the *sawah* towards the river. It was essential to keep the "leas" as short as possible because any attempt to push soil more than about 30 ft. resulted in the loss of a considerable portion around the outer edges of the blade. When borrow pits are necessary to provide additional spoil for the formation of the bund they should preferably be dug on the side of the bund adjacent to the river so that they may be self-draining, but, where the ground is soft, the operation of the bulldozer within a few feet of the edge of the river is dangerous, and, unless it is essential to have a wide "berm" between the bund and the river, it is better to work from the *sawah* side under such conditions.

The D.4, however, is a very flexible machine, and in the hands of a capable operator the bund can be sited almost at will, irrespective of the proximity of the spoil bank to the river, but for economical construction it should be sited as far as possible within the limits of the spoil bank.

If, therefore, a river is being dredged with a view to constructing a bund from the dredgings at a later date, the spoil should be thrown as far away as possible from the bank of the river and the volume of the dredgings should be at least sufficient for the formation of the bund. In swampy ground, due allowance should be made for the fact that a portion of the spoil tends to disappear into the subsoil in the course of time.

The weather at the end of October 1947 broke before the bund was completed but the machines continued to operate satisfactorily and little trouble was experienced with bogging as long as the machines worked within the limits of the comparatively solid spoil bank and good drainage was maintained. No mechanical trouble of any consequence was experienced until the middle of October when a synthetic fibre timing gear in one of the bulldozers broke. This type of gear was apparently introduced for silent running, but it has been replaced in later models by a steel gear of more rugged construction.

The total length of bund constructed is 12,500 ft. and the amount of earthwork is 19,600 cubic yds. The top width of the bund is 5 ft. with side slopes of $1\frac{1}{2}:1$. The average height of the bund is 4 ft. but it reached a maximum of 6 ft. in places. The rate of construction varied considerably depending on the weather and the nature of the spoil bank but it averaged 90 linear ft. per day (140 cubic yds. of earthwork). The average cost of earthwork per cubic yard of bund, including operating costs of bulldozers, but excluding depreciation, was 25.2 cents. The cost per cubic yard for trimming and turfing was 14.7 cents, making a total of 39.9 cents per cubic yd. of completed bund. The useful life of bulldozers under severe working conditions is estimated at 10,000 working hours, but judging by the almost complete absence of mechanical trouble during the construction of the bund, the estimated life could be taken as 15,000 working hours under the actual conditions of operation at Krubong. The additional estimated cost per cubic yard of bund due to the depreciation of machines under such conditions would amount to 14.5 cents, making an all-in-cost of construction per cubic yard of 54.4 cents. The estimated cost of doing the work by manual labour at present would be 80 cents per cubic yard, and consolidation would be definitely inferior to that obtained by the bulldozers.

Selected Articles.

AGRICULTURAL MACHINERY*

In view of the shortage of machinery in Malaya and the difficulty of obtaining early delivery, the following article, which gives the reasons for a similar state of affairs in Great Britain, is of interest. (*Ed.*, *M.A.J.*).

The increased production of food from the land is one of the main planks in the recently announced crisis programme. Although ours is a very highly mechanized industry, as compared with the agriculture of other countries, farmers have never before complained so much about the shortage of tractors, ploughs, mowers, and most other agricultural machines.

The Government has promised a substantial increase in the allocation of raw materials so that manufacturers can increase their output of tractors, machines and implements. But let us try and get an appreciation of the position, past, present and future, and an understanding of what is involved in the manufacture of farm implements; because it must be understood that supplies cannot suddenly become adequate, even though the supply of materials needed for making farming equipment is given favourable treatment.

War-time Mechanization.

Between 1939 and 1945 the dire need to grow more food compelled us to make, import and buy more and more machinery to cultivate and harvest the many new acres which came under the plough. Then labour became scarcer, less skilled in part, and later more expensive. The demand for machines to do the work consequently grew, and as more and more fields came under crops, and there were fewer hands to deal with them, so an increasing number of machines were wanted to make up the deficit.

Despite bombing, the call up of mechanics and foundry men, shortages of raw material, requisitioning of factories or parts of factories, British manufacturers during the war managed not only to maintain essential production programmes but in most cases to increase them. As metals and timber grew increasingly scarcer it became necessary for the Government to restrict, and even to prohibit, the making of certain lines and to insist on fewer specialized types of different implements and machines—a process to which the name of "streamlining" was applied.

So vital was this question of the best use to make of the limited supplies of raw materials that a special branch of the Ministry of Agriculture was set up to deal with it. The manufacturers themselves helped the work of this branch through the Joint Standing Committee of the Agricultural

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* The Production of Agricultural Machinery, by Cornelius Davies, *Journal of the Ministry of Agriculture, Vol.* LIV, page 302, October, 1947.

Engineers' Association. That branch of the Ministry still operates, because, as is generally known, the supply position of raw materials has not improved since the end of the war.

For imports we relied on the U.S.A., Canada and Australia. For the first time in history Australia sent the Mother country farm machinery; reapers and binders to begin with, and later ploughs, drills and other things. It was an historic occasion when the first Australian binders were put to cut corn in Bushy Park—land which had not been under the plough for a hundred years.

Canada had, of course, been sending us machinery for many years, and we continued to import from her on an increasing scale. From the States, also an old supplier of ours, Cash-and-Carry and then Lease-Lend helped us to mechanize our agriculture still further. When Lease-Lend terminated, as it was due to after VE Day, imports from America came on a dollar basis, and we were short of dollars. Also the American farmers were short of farm machines. One can quite imagine some of them asking during the war why tractors and implements, badly needed on their own land, had to be exported in such large numbers.

It must always be remembered that the Americans were extremely generous to us during those critical war years. We still get agricultural machinery from North America, but for various reasons we cannot bring over all that we should like.

Increased Output: The Manufacturer's Problem.

From the manufacturing point of view it is as well to try to understand what is being done in this country to-day and to appreciate fully the obstacles which prevent the farmer getting all the machines and equipment he would like, as soon as he wants them.

To many townsmen a farmer is a farmer, and as such should be capable of growing corn, sugar beet, fruit, flax, milk, pork, wool, or any of the other products of the land, without much difficulty. The same townsman often thinks that to change over from beef production to corn growing is a quite simple matter, because it is all part of farming. He also considers that a sudden large increase in acreage, or in numbers of stock, is easily accomplished. The farmer knows how wrong he is! But the farmer, on his part, often thinks that a manufacturer of rollers and harrows can easily switch over to make mowers and binders; and that a firm which has normally been turning out a couple of thousand machines of a particular class in the year should be able to meet a demand for three or more times that number without much trouble.

A factory of a given size has an optimum output of ploughs, tractors, or disc harrows, and at a squeeze, provided everything falls nicely into place, that output can be increased; but there is a maximum beyond which it is not possible to go, in the same way that there is on a farm which is producing corn, milk or fat stock.

For the manufacturer to increase his output of existing lines of machines he needs more staff, more machine tools, more iron and steel, more floor space, more buildings, more capital, more things like nuts and bolts, bearings, wheels and similar bought-in parts, all of which are almost invariably obtained from specialist firms, and these specialists have their own production troubles. Quite a few manufacturers have enlarged their plant to meet greater demands, and they have done that on the assumption that there will be work for their increased capacity for many years to come. Others who have been held up mainly for raw materials should soon be able to increase their output. Some firms are completely surrounded by neighbours' buildings and cannot therefore increase the size of their factories; but given the necessary equipment, materials, and skilled labour, most of them will be able to increase output at least to some extent.

To turn over to the manufacture of a line not previously made on anything but a negligible scale very often requires a completely new and fully equipped factory. A surplus Government factory might be available; but it would be little short of a miracle if the tools in it were found to be suitable for making combine harvesters, tractors, deep-digger ploughs or any other farming machine. In all likelihood the tools installed in the first place were designed for the making of tanks, guns, or aeroplanes.

Some firms have acquired such factories; they have invested many pounds in modifying them, and, with a great deal of faith in the future of British agriculture, they have started to make the farm machines for which there is, at present, so great a demand.

Inventions and their Translation into Practice.

Now let us consider new inventions, that is, machines which have passed the rough sketch and meccano-model stage and, by the efforts of a gifted but perhaps technically untrained inventor, have emerged as a working machine ready to be tried out in the field: that wonderful machine we read about for harvesting potatoes, separating the tubers from the soil, haulm, weeds, stones and clods, and then grading and bagging the potatoes; or that cheap dung loader which takes all the sweat and ache out of the job; in fact any of the devices we hear about and which most of us need. Inventors sometimes complain that they cannot get their ideas developed, made and marketed; that vested interests combine to keep them out; or that manufacturers are too conservative to want anything new and better. Before jumping to these conclusions it is as well to have some knowledge of the manufacturers' problems.

Just suppose that the rough home-made model has put up a thoroughly satisfactory performance under a number of different soil, plant and weather conditions—and this is rare indeed—and that a firm is prepared to consider large-scale production. Before embarking on the project the management must do some market research, i.e., it must endeavour to find out just what the demand is. Will it be really large? Is it likely to last

for a number of years or is it just a passing fad? Will there be an export market, and will farmers be prepared to pay the price which the machine is going to cost?

The manufacturer simply cannot accept a few strident calls at a farmers' meeting, or some strongly worded letters to the press, that such a machine is wanted, and wanted in sufficient numbers to justify the further steps that he, the manufacturer, must take; any more than an arable farmer would change his cropping system to grow yams or pineapples—if those things could be cultivated on his farm—because there had been some clamour for them.

Assuming that the result of his inquiries is favourable, the manufacturer has then to plan his production. Probably whilst sounding the markets he has been experimenting with the original model, evolving what is called a production prototype—perhaps substituting malleable castings for some too expensive machined parts, re-designing the main frame, so that it will be stronger yet lighter and cheaper to make, and so on.

Getting into Production.

And now for production. Shall some of the firm's old lines be discontinued to make room for the newcomer? Will the machine tools and other factory plant be suitable; and what new lathes and grinders, heat treatment ovens and automatics are required? Things like jigs, for the accurate drilling, welding and fitting together of components have to be designed and made. Orders for raw materials have to be placed, orders given for finished parts like bearings, wheels, gears, pulleys, chains.

Perhaps one part of the new machine will have to be pressed out of light sheet metal and the tools to do this have to be bought, perhaps from abroad. Some of these press tools cost hundreds, even thousands, of pounds, and the dies, the shaping parts of the tool, may take months to make before the tool can be put into operation.

All this is engineering; but there are many specialist sections involved and the management has to co-ordinate the activities of all the specialists to get the best results. The management has also to plan other sides which are not in the engineer's province, such as sales, distribution, discounts, servicing, exports and the supply of spare parts.

It may be said that the above picture is one of a vast mass-production factory. That is not necessarily the case at all. If a firm is to make anything but a mere dozen or so machines, all the planning that has been outlined, and a good deal more, has to be undertaken and considered.

Eventually, when the first batches of the new machines come off the production lines, there will almost inevitably be defects of design, material or assembly. Some of these faults are not apparent until the machines actually get working under farm conditions. All reputable manufacturers want to know about such weaknesses and faults, and they take steps to remedy them.

It does no good whatever to vilify in public and in private such new ventures because of early faults. Some critics may say that the original model was a success, so why then did the manufacturers play about with it? Why did they not turn out a copy? The answer is that economically, if not physically, it is not always possible to produce exact replicas, if new types of machines are not to cost many times more than the planned prices, and makers are to employ modern production methods.

No mention has been made of present shortages of fuel, materials and labour, all of which increase the difficulty of production planning, but with the special recognition now being accorded to farm machinery we can confidently expect more tools for the land.

This account of farm machinery production problems is an attempt to give farmers an insight into the makers' difficulties and to explain why the industry has not been able to meet all the demands for crawler tractors and combine harvesters (a demand, by the way, not quite so large as it is often represented to be), and the more usual implements we normally make in this country.

The Government has recognized the urgency of the need for more farm machinery, and it can be taken for granted that the agricultural engineering industry will do its utmost to deliver the goods.

HORTICULTURAL TRACTORS*

For small-holders of all nationalities, it is probable that miniature tractors of 1 to 10 h.p., generally known as 'horticultural tractors', will be in greater demand than those of higher cost. Types produced in both the British Isles and the United States of America are being imported into Malaya for testing. The following selected article describes, in general terms, the range of tractors at present being manufactured, and indicates the general trend of evolution. (*Ed.*, *M.A.J.*).

There is a growing demand, based on the success of the mechanization that has already been applied to horticulture, for what are generally termed horticultural tractors. There has been a marked increase recently in the range of models available; and to-day there are small tractors and associated implements suitable for use by even the smallest-scale grower. Advantages of mechanization include an increased yield and a saving in labour, resulting in a more economic production of higher quality crops; and, possibly, the elimination of dependency on horses and the introduction of operations that would not be possible by hand. The mechanization requirements of horticulture are more extreme than those of agriculture, for on a large farm the equipment can often be a multiplication of that required on a small farm, but within the range of horticulture the needs, for example, of a grower with half an acre are not the same as for one with a 10 or 20 acre holding, nor is the mechanized equipment suitable for, say, a tomato grower likely to be of use to a market gardener specializing in field crops. The success of any attempt at mechanization must, therefore, be very largely dependent on the correct choice of equipment in relation to the type of work for which it is required.

Power units of horticultural tractors may be said to range in size from 1 to 10 h.p.; and in type to include baby three or four wheeled and tracklaying tractors, a wide variety of two-wheeled or so-called walking tractors, and self-propelled tool frames. With the current trend to make all implements directly attachable to a tractor, the difference between the tractor, to which implements are attached, and the tool frame or chassis, to which, virtually, an engine is attached, is becoming less obvious. The practical distinction between the two is largely in the degree of power available, and a choice should be made on this consideration. The self-propelled tool frame is a very suitable machine for farmers with an acreage of market garden crops; all operations from seeding onwards can be covered by the standard frame equipment, and a row-crop tractor is, therefore, unnecessary. The walking tractors include a wide variety of models and may be divided into three classes according to the heaviest operation of

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* Horticultural Tractors, W. H. C., *Agricultural Engineering Record*, Spring 1947, National Institute of Agricultural Engineering, Askham, Bryan, York, England.

which the power unit is capable: the hoeing class, of 1 or 2 h.p.; the cultivating class, of 3 or 4 h.p.; and the ploughing class, of from 5 to 10 h.p.

Hoeing Tractors.

The work of tractors in this class is confined to hoeing, a working width of 1 ft. 6 in. requiring about 1 h.p. The smaller machines in the group are little more than hand push-hoes, with the power for pushing provided by the engine. The advantage over an ordinary push-hoe is that there is less fatigue, thus making it possible for a man to work a longer day and in some circumstances at a greater speed. It is generally considered more satisfactory to hoe each side of a single row of plants than the adjacent sides between two rows. This method permits more accurate work, as it enables the hoes to follow the exact line of the drill. Similarly, for a larger machine with four hoes, it would be more satisfactory to hoe at one time each side of two rows of plants than to hoe both sides of a centre row of three and one side only of each of the two outer rows. A single-wheeled tractor is limited to an even number of rows, but a two-wheeled machine can deal with either an odd or even number according to whether it straddles one or two rows. With crops that have grown tall, however, it is not practicable to straddle rows, and a single-wheeled tractor is then more suitable.

Hoes are mounted either in front or behind the axle. A difficulty that arises when hoes are mounted behind the axle is that they necessarily move in the same direction as the steering handles when these are moved sideways. In other words, if the hoe blades are running too near to the plants on one side, the tractor has to be steered to the opposite side, but, momentarily, the hoes will run farther into the plants. The greater the distance between the hoe axis and the wheel axle, the worse is this effect, and it is important, therefore, that the hoe should be attached as close behind the wheels as possible. If the hoes are mounted in front of the axle, steering troubles will be avoided, but other disadvantages are introduced; the wheels run on ground that has been hoed; the operator has difficulty in seeing his work; and the reaction of the engine tends to lift the hoes off the ground, thus causing extra fatigue. In any case, this class of machine should never be expected to work under rough conditions, when control would be difficult and close work impossible.

Cultivating Tractors.

The machines in this class, 3 or 4 h.p., have sufficient power to hoe at least a 4 ft. width. The working width for cultivating is, of course, reduced according to the depth of the work. To obtain the necessary adhesion these machines usually have two wheels, with means of altering the width of track. They are capable of cultivating one row of potatoes, and the range of available equipment generally includes discs and seeders.

Increased width of work, however, makes them more difficult to steer accurately. The tractors in this group are capable of only shallow ploughing; but on a comparatively small holding, where standard ploughing and deep cultivations can be done by a contractor, one of these machines will suffice for other operations.

Ploughing Tractors.

These machines, of from 5 to 10 h.p., are the most powerful two-wheeled tractors. They plough satisfactorily and are also capable of use with a full range of equipment that includes seeders, discs, cultivators, and sprayers. The machines have more power than can be fully utilized for light work, and are generally too cumbersome for hoeing. Some mechanical device is usually fitted to assist in turning the tractor sharply when on the headland.

Ploughing is more important to the horticulturist than any other basic operation, and the class of work required often demands the tractor's maximum available power. A 6 h.p. tractor cannot be relied upon to pull more than 400 or 500 lbs. at working speeds. When ploughing is required to bury surface growth, the furrow-slice should have 3 ins. of width to every 2 ins. of depth; so in order to plough, say, 6 ins. deep the furrow width must be not less than 9 ins. and the cross-section is, therefore, 54 sq. ins. If a 10 lbs. pull per sq. in. is taken as an average soil resistance, the 540 lbs. pull required is about the limit of a 6 h.p. tractor's ploughing capacity. In practice, these tractors can plough rather less than 6 ins. deep on grassland and slightly over 6 ins. on arable land, and the working rate is about 0.5 acre in 8 hours on grassland and 0.9 acre on arable. The setting-up of ridges and finishing-off of furrows is an awkward operation with a two-wheeled tractor, and the subsequent irregularities in the land surface are a serious drawback. They can be avoided by the use of reversible, or one-way, ploughs of the type in general use on the Continent. These ploughs can turn the furrow-slice either to the right or to the left, and it is expected that their use will become more popular in this country.

Rotary Cultivators.

Rotary tillage is a very promising alternative to ploughing, for under suitable conditions a tilth can be obtained in one operation. Unlike ploughing, it is not necessary to relate the width of work to the depth, and a working width can be used that will suit the power unit. Rotary tillage is most effective in the drier periods of the year, when weeds can be killed without being completely buried. A market garden rotary cultivator is generally a separate tool, but some horticultural tractors have a rotary tiller included as part of their alternative equipment. A criticism of rotary cultivation is that it leaves the ground too "fluffy"; although this may be so in some circumstances, the fact that land can be worked at any depth from 1 to 9 ins. makes it possible to avoid a tilth too loose for root growing.

On the Continent a rotary cultivator with a range of speeds for the rotor has been produced, and this development should be helpful in making rotary tillage successful for a wide range of soil conditions.

Design Features.

Single-wheeled machines are usually equipped with a steel wheel, and this is necessary to give the required adhesion. Medium-sized two-wheeled machines may be obtained with either steel wheels or pneumatic tyres. The larger models have sufficient weight to enable ploughing to be carried out. If heavy ploughing is required from a two-wheeled tractor, extension rims can be fitted to increase the width of the steel wheels. Detachable tracks are better, and enable a much greater pull to be obtained than is possible with steel wheels. Such tracks are an alternative to steel wheels and form a very useful adjunct for a tractor with pneumatic tyres. The winch attachment described in the Spring 1946 issue of the "Record" enables a 6 h.p. market garden tractor to exert a pull of 2,200 lbs. The device would make possible, at a reduced speed, all the deep cultivating and ploughing required for a small area. It is not in production, although one manufacturer is considering it.

Finally, it may be repeated that the possible success of mechanical equipment for small-holdings depends entirely on correct choice. A first consideration should be the acreage to be worked, and, unless this is very small, there are good reasons for choosing two tractors—a small one for hoeing and a larger one for ploughing and cultivating. The total initial cost of two tractors may be higher than that of the larger one with full equipment, but the time saved in changing implements and the saving in fuel on light operations, together with the greater convenience when handling a light tractor on light work, recompense the extra cost. With reasonable care and maintenance, the life of a market garden tractor should be about 600 working days or 4,000 hours; but for calculation of working costs, half this life may be taken and any estimate of replacements ignored.

Reviews.

AGRICULTURAL ENGINEERING RECORD

Published by the National Institute of Agricultural Engineering, Askham, Bryan, York. Issued quarterly. Price 1 shilling per issue.

The purpose of this publication is to place on record, for the benefit of manufacturers and farmers, results of the work of the National Institute of Agricultural Engineers, progress of other developments and research work and observations on practical farming. This information should further the collaboration between experimenters, manufacturers and farmers, without which there can be no true progress in mechanisation. Users of farm machinery should be particularly interested in some recent reports issued by the N.I.A.E. on machines submitted for commercial tests, summaries of which are published with the consent of the firms concerned. Regular features also include some of the findings of the Farm Mechanisation Inquiry, which has been maintaining close contact with practical machinery problems, and has completed two years' detailed records of tractor and implement usage on some 70 farms in the United Kingdom. The first issue was published in autumn, 1945.

AGRICULTURAL ENGINEERING

A Journal of the American Society of Agricultural Engineers. Published at Benton Harbor, Michigan, U.S.A. Issued monthly. Price $3 (Gold) a year, plus postage.

This journal, the first issue of which was published in 1920, contains many articles of particular application to the U.S.A., especially as regards soil conservation. Most of the articles are of a highly technical nature and will have little application to Malaya, but one, an article in their issue for September, 1947, " Fundamentals of the Mechanical Tree Planter—Design and Performance " by H. D. Bruhn and F. B. Trenk, will be of considerable interest to readers in this country.

POWER FARMING IN AUSTRALIA

Published by the Sydney and Melbourne Publishing Co. Pty. Ltd., 29, Alberta Street, Sydney. Issued monthly. Subcription Rates: Australia and New Zealand, 10 shillings per annum; overseas: 15 shillings per annum, post free.

This is a popular journal, concerned with power farming, motor tractors, agricultural machinery, rural electrification and farm and dairy mechanics. It contains articles on the mechanics and maintenance of tractors and implements and has notes on modifications made to implements by farmers in Australia.

FARM MECHANISATION

Published by Temple Press Limited, Bowling Green, London, E.C.1.
Issued bi-monthly. Price 1 shilling.

This magazine, which claims to be a link between farming and engineering, contains articles on subjects of great interest, many of them written by well-known authorities. Although mainly concerned with improvements in farm mechanisation in the United Kingdom, nevertheless it has articles or notes on such subjects as " Machinery for groundnut growing " and " The use of two-wheel tractors to supersede manual labour in rice-growing areas." Features of each issue are " Hints and tips on maintenance " of certain types of tractors, " Farming and Machinery Notes " and reviews of agricultural and engineering books.

E. J. H. B.

Departmental.

FROM THE DISTRICTS

Compiled by the Chief Field Officer from Monthly Reports of Agricultural Officers.

September, October, November and December, 1947.

The Weather.

Heavy rain fell during the second half of September in Kedah and continued during October, resulting in much flooding throughout the State. Light showers with strong easterly winds were experienced in November. A heavy storm occurred in the Krian District of Perak on the 23rd September, resulting in floods in several localities. At Titi Serong, 9½ ins. of rain were recorded on that day. Rainfall during October and November was below average. It was unusually hot and dry during the latter month in Perak. The monsoon started at Kota Bahru, Kelantan, on the 15th October, and increased in severity during the latter part of November. The rainfall was low in Selangor, especially so during October and November when drought conditions developed in many places. In Johore, rainfall on the east coast was more normal, but hot and dry conditions continued during November over most of North and Central Johore. Exceptionally heavy rain occurred on the east coast and on the main range during December, and caused serious floods in Kelantan, Trengganu, Pahang and Perak; 43 ins. were recorded in 23 days at Ulu Trengganu.

Crop Reports.

MAIN CROP—PADI.

General.—Estimated figures for the 1947-48 season show that 822,867 acres of wet and 84,015 acres of dry padi will be planted, an increase of 90,253 and 3,091 acres respectively over the 1946-47 figures. Given average yields, the total padi crop, including that grown in the offseason, should yield 207,184,500 gantangs of padi or some 326,275* tons of rice, an increase of 27 per cent. over the 1946-47 figures. With regard to the acreage under wet padi, the increase of 90,253 acres consists of 40,473 acres of new padi lands and 49,780 of reclaimed padi lands, while in addition, improvements to drainage and irrigation and the supply of seeds and manures should increase the yield on at least 150,000 acres; 70,677 acres remain unplanted.

These increases have been made all over the country in both large and small padi areas and it is impossible to describe them in detail, but as an example, the case of Malacca may be considered. Here the more important undertakings which have been successfully completed during the last 6 months were:—

* The conversion of padi to rice is now calculated on the basis of 635 gantangs of padi to 1 ton of rice. The former figure of 666 has been reduced owing to the higher milling percentage recovery of 63 per cent. as compared with the former figure of 60 per cent.

(1) The clearing of 12,251 chains of distributaries and drains.
(2) The clearing of 6,209 chains of rivers.
(3) The construction of 32,380 ft. of bunds to prevent the entrance of sea or flood water into low-lying padi areas.
(4) The construction of brush and cement dams for the improvement of irrigation.
(5) The issue on loan of 405 tajaks, 86 axes and 86 changkols to needy cultivators.
(6) The free issue of 920 rounds of ammunition for pest destruction, and an increase in the rat destruction staff.
(7) The distribution of 3,148 piculs of bones, which is sufficient to manure 6,296 acres at local rates of application.
(8) The issue of 8,437 gantangs of padi seed.

District Reports.—In almost all districts in Kedah the acreage under wet padi has increased substantially from that of last season. There has been a marked absence of disease, and damage by rats has been kept down to a minimum. Some damage from wild pig occurred in the interior and remote areas. In some districts damage resulted from flooding and the entry of sea water into the padi fields on the coast. The majority of the crop is making good growth and local opinion considers that the very large distribution of bat guano throughout the State by the Department has played a great part in the satisfactory growth of the padi. Harvesting was under way by the end of the year.

The general health and growth of the padi in the Krian District of Perak is excellent and rat and other pest damage is negligible. Shortage of rain in Lower Perak resulted in transplanting being prolonged, and in areas entirely dependent upon rainfall transplanting was only commencing in November. Very severe flood damage occurred during December; some 3,000 acres in the Parit District have probably been completely destroyed by floods; the padi was in the flowering stage.

Crop prospects generally throughout Pahang were good and harvesting started in many districts, but the December floods caused very severe losses in many areas.

Drought conditions in the main coastal area of Selangor resulted in a serious situation and many nurseries were useless. In irrigated areas most of the transplanting is finished but it was difficult to maintain the water level until the rains started in December. At Sawah Sempadan prospects are very good.

In Negri Sembilan harvesting was nearly completed; yields are better than last season, but there was some damage by minor floods, and pig damage in some areas was severe.

Inadequate rainfall in many districts of Malacca caused anxiety, but the situation was saved by rain early in December. In inland districts,

i.e., Alor Gajah, as well as parts of Jasin and Masjid Tanah, harvesting was in progress and a better crop than last year being reaped.

In Kelantan it is estimated that 3,000 acres have been destroyed by floods and a further 4,000 acres were damaged, but the deposit of silt is likely to be beneficial in the long run. In Trengganu the full extent of the flood damage is not yet estimated, but it is known to be considerable.

Reports indicate a continuance of satisfactory conditions in padi areas in Johore; there is practically no pest damage, and crop prospects are good. Most of the padi in Kluang District is flowering and crop prospects remain satisfactory. An exceptional yield of 500 gantangs of padi per acre is estimated from an ammonia irrigated field at Rengam, caused by the effluent from an adjoining latex factory becoming incorporated in the irrigation supply.

Offseason Crops.

It is estimated that 2,528 acres of wet padi grown during the offseason yielded 177 gantangs per acre while 477 acres of dry padi yielded only 14 gantangs per acre to give a total of 454,761 gantangs of padi or 683 tons of rice. In addition considerable acreages of maize and groundnuts were planted but little interest was shown in ragi.

Rubber.—Prices commenced to increase during September and rose steadily until final prices during December were around $50 per picul for smoked sheet, an increase of about $15 per picul during the period. In Negri Sembilan, numerous applications for land for new rubber planting were reported. Over 10,000 acres have been asked for in Tampin District, 1,300 acres in Rembau District, and 645 acres in Jelebu District.

As a result of the increase in price there was a rise in the percentage of small-holdings in tapping to 83 per cent. of the total acreage in Malacca. In Johore Central and North Circles it is estimated that about 75 per cent. of rubber small-holdings were in tapping during November.

Coconuts.—There was a general increase in price for copra and coconuts. The price of copra in Penang rose to $29, and oil mills in Selangor were paying up to $28 per picul.

The Departmental travelling copra drying unit gave demonstrations at the Kuantan Agricultural Show, Pahang, and afterwards continued the demonstration of the improved type of drying kiln in Trengganu and Kelantan. Much interest was shown by small-holders in these demonstrations in all districts visited, and in several places the intention of erecting improved kilns has been expressed.

Foodcrops and Vegetables.—Considerable interest has been taken in sago extraction; the number of temporary sago factories in Malacca increased to sixteen. The average price of sago flour in November was $23 per picul.

The cultivation of bitter cucumber by Chinese, who specialize in this crop, has increased in Negri Sembilan and Selangor. A high standard of cultivation is attained and large crops have been harvested.

The output of vegetables from Cameron Highlands district for November was estimated at 650 tons. Growers are now tending to cultivate a larger variety of vegetables instead of concentrating on cabbage production. The Department imported 3 tons of seed potatoes from Australia, and 40 piculs were distributed to growers during November. The price of vegetables grown at the Highlands is largely dependent on whether supplies arrive at Singapore from Australia and China; it declined during the last two months of the year.

Investigations into Mechanical Cultivation.

Interim reports on the progress already made will be found in the articles in this special mechanisation number of the *Malayan Agricultural Journal*.

Miscellaneous.

Demonstration Vegetable Plots.—Sites for demonstration vegetable plots at Brinchang and Ringlet, Cameron Highlands, were selected and arrangements made with the occupiers to undertake a programme of work demonstrating the results of experience gained at the Experiment Station, Cameron Highlands.

Destruction of Animal Pests.—A total of 1,100 shot guns was distributed to all States and Settlements during the period under review. Ammunition became available in some quantity and very encouraging reports have been received regarding wild pig destruction. In the Raub District of Pahang, a concentrated campaign was undertaken during the last ten days of November and early December; a total of 85 shot guns was concentrated in Raub and Budu, and in the former District alone over 300 wild pig were shot.

In Negri Sembilan 1,202 wild pig were destroyed by various means during December. Poisoning was carried out with some success in Pahang. In all, it is estimated that 30,000 wild pig were destroyed in the Union during the last 4 months of the year.

The campaign against rats continued unabated; at least 150,000 were accounted for between September and the end of the year.

Fresh-Water Fish.—Fish ponds were constructed at the Boys' Home, Serendah, Selangor, with the advice of the Chinese Agricultural Assistant. Excavation work was undertaken with the use of a bulldozer hired from the Army for the purpose.

Many local ponds in Selangor came into production during September and prices for fresh-water fish declined. Grass-eating carp were quoted at $1.60 per kati as against $2.40 some months ago. In Negri Sembilan also there was great activity in reconstructing ponds coincident with the arrival of fry from China at considerably lower prices than hitherto.

Farms.

The recommendations of the Departmental Technical Committee, which visited all Government Farms during March and April, 1947, has been implemented as far as possible. Of the 5,777 acres which had been cleared when the Farms were taken over by the Department of Agriculture, 1,723 have been handed over to squatters, 2,634 have been abandoned, and 1,420 are being planted, mainly with dry padi. Those areas which are in Selangor and Province Wellesley have suffered to some extent from droughts, pests and disease, but in both areas, especially in the latter, some fields are showing promise.

DEPARTMENTAL NOTES

Retirement of Mr. J. N. Milsum O.B.E., F.L.S.

Mr. J. N. Milsum, Chief Field Officer, left Kuala Lumpur on the 1st January, 1948, on leave prior to retirement, after a record service of over 34 years in the Department of Agriculture, Malaya. He was first appointed to Government Service as an Assistant Superintendent, Government Plantations, F.M.S., on 31st October, 1913, and his retirement severs the final link in the chain of departmental personnel whose service antedated the Great War 1914-18.

Mr. Milsum received his initial professional training at the Royal Botanic Gardens, Kew, and supplemented this later by a course at the School of Agriculture, Cambridge University. He thus acquired early the strong botanical bias which was to characterize his whole career and which, in conjunction with his own outstanding enthusiasm and talents, has earned for him an enviable reputation as an authority on the flora, and particularly the economic flora, of Malaysia. His interests and knowledge have not been confined to Malaya alone for he visited Sumatra on special duty in 1921 and 1933. He was a delegate to the Fourth Pacific Science Congress in Java in 1929 and paid a further official visit to that country in 1934, while in 1935 he was Malayan Delegate to the 3rd Imperial Botanical Conference, London, and to the 6th International Botanical Congress, Amsterdam.

By far the greater part of Mr. Milsum's service was spent in the Division of Agriculture, Research Branch, of the Department and in this Division he was promoted in turn to the posts of Assistant Agriculturist and Senior Assistant Agriculturist. He acted on various occasions in the post of Senior Agriculturist and in these various capacities he was first intimately associated with the development of the initial system of Government Plantations and Gardens. Later, over a period of some 16 years, he was largely responsible for the establishment and development of the Central Experiment Station, Serdang, and it has often been said that this Station probably constitutes his most significant contribution to the agricultural progress of this country.

Mr. Milsum's professional knowledge and administrative abilities were fittingly recognised in 1937 by his promotion to the post of Senior Agricultural Officer and by his transfer in 1938 to the Field Branch in the senior post of State Agricultural Officer, Perak. He was serving in this post when the Japanese invaded Malaya in 1941 and was embodied with the Perak Local Defence Corps. Together with many of his contemporaries he has imprisoned throughout the occupation in the Civilian Internment Camps, Singapore, where he quickly assumed a leading role in the food production activities and was in fact appointed to the post of Camp

Gardens Officer by the British Camp Commandant in 1943. He held this post until the Japanese capitulated in August, 1945, and his outstanding services under these extremely difficult circumstances earned for him the thanks of the Secretary of State for the Colonies and the award of the Most Excellent Order of the British Empire in 1946.

Mr. Milsum quickly recovered from the effects of internment and, though over-age and in a position to retire had he so wished, nevertheless agreed to return to Malaya to assist in the rehabilitation. He arived back in this country on 8th May, 1946, and completed his notable record of service as the Head of the Field Branch of the Department in the post of Chief Field Officer.

Mr. Milsum was throughout his service a prolific contributor to agricultural literature; he possessed in high degree the gift of clear exposition and has to his credit a most impressive list of Special Bulletins and articles in this Journal, of which he was either the senior or associate author. Always ready to place his wide knowledge at the disposal of others his quiet, kindly and generous disposition earned for him a unique place in the affections and esteem of his colleagues. Members of the Department and numerous friends join in wishing him and his wife a long, happy and well-earned retirement.

V. D.

Appointments.

Mr. J. R. P. Soper, State Agricultural Officer, Selangor, has been appointed to act as Chief Field Officer, Department of Agriculture, Malayan Union, with effect from 1st January, 1948.

Mr. H. L. Barnett, Agricultural Economist, has been appointed to act as Registrar of Statistics, Malayan Union, in addition to his other duties, with effect from 23rd December, 1947.

The Right Honourable the Secretary of State for the Colonies has been pleased to approve the appointment of Mr. Leslie Norman Hastings Larter, Senior Botanist, Jamaica, to be a Botanist, Malayan Agricultural Service, with effect from the 17th October, 1947.

Mr. B. G. A. Lowe, Agricultural Officer, Johore Central, has been appointed to act as Agricultural Officer, Johore North, in addition to his other duties with effect from 12th October, 1947.

Mr. V. Dawson, Principal, School of Agriculture, Malaya, has been appointed Principal, College of Agriculture, Malaya, with effect from 3rd July, 1947.

Leave.

Che' Tak bin Haji Daud, Malay Agricultural Assistant, Grade I, has been appointed to act as Malay Agricultural Officer, Kelantan, with effect from 3rd June, 1947.

Che' Ja'afar bin Mampak, Malay Agricultural Officer, has been appointed Malay Agricultural Officer-in-Charge, Trengganu, with effect from 11th May, 1947.

Mr. F. S. Banfield, Assistant Agricultural Officer, Malayan Agricultural Service, has been granted 112 days leave in addition to voyages with effect from 22nd November, 1947.

Mr. J. N. Milsum, O.B.E., Chief Field Officer, has been granted 293 days leave prior to retirement with effect from 5th January, 1948.

Mr. R. G. Heath, Senior Agricultural Officer, returned from leave on 22nd December, 1947, and assumed duty in the post of State Agricultural Officer, Selangor on 1st January, 1948.

Mr. H. L. Barnett, Agricultural Economist, returned from leave on 22nd December, 1947.

Promotions.

The Right Honourable the Secretary of State for the Colonies has been pleased to approve the promotion of Mr. H. L. Barnett, Assistant to Agricultural Economist, to be Agricultural Economist with effect from 1st January, 1947, inclusive.

Transfer.

Mr. J. W. Jolly, Senior Agricultural Officer, was transferred from the Malayan Establishment on confirmation of his appointment as Director of Agriculture, North Borneo, in which post he had been acting on secondment since 21st November 1946, from which date his promotion and transfer take effect.

MARKET PRICES

December 1947.

Rubber.—During October the Singapore price of rubber made a gradual advance from 32½ cents to 39⅜ cents per lb. and this advance continued in November until the price reached 44⅝ cents on the 13th day of the month, after which there was a decline and November closed with the price at 41¾ cents. The decline continued in December until 39½ cents was reached on the 11th December. The next day the price advanced 1 cent and varied between 40 and 43 cents to close at 42½ cents per lb. on December 30th.

The Singapore average prices for rubber during the period were—October, 35½ cents per lb., November, 42 cents per lb. and December, 40½ cents per lb.

The average prices paid for small-holders' rubber at three centres during the last quarter of 1947 are given in Table I.

Table I.

Average Monthly Prices Paid by Local Dealers for Small-Holders' Rubber, October-December, 1947.

(Dollars per picul of 133⅓ lbs.)

Grades	Kuala Kangsar, Perak.			Kuala Pilah, Negri Sembilan.			Batu Pahat, Johore.		
	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.
Smoked Sheet ..	41.92	50.55	46.33	38.75	50.31	47.13	38.27	46.79	46.55
Unsmoked Sheet ..	34.50	43.85	39.66	35.00	45.12	42.56	34.31	43.58	42.10
Scrap ..	14.20	16.75	17.00	11.50	15.88	13.13	14.08	16.91	13.63

Transport from Batu Pahat to Singapore by lorry, excluding duty, $1 per picul.

Table II.

Singapore Prices of Various Agricultural Products.

Product	December, 1947			November 1947	Average Price Jan.-Oct. 1941
	Highest	Lowest	Average	Average	
	per picul $	per picul $	per picul $	per picul $	per picul $
Copra:					
Sundried No. 1 ..	37.00	32.50	34.95	26.08	2.58
No. 2 ..	*	*	*	*	2.33
No. 3 ..	*	*	*	*	*
Coconut Oil ..	65.00	62.00	63.12	41.82	8.64
Coffee:					
Padang Bali No. 1 ..	95.00	92.00	93.53	97.56	*
No. 2 ..	91.50	88.00	89.90	93.52	*
Palembang No. 1 ..	88.00	80.00	82.00	78.48	18.07-19.91
Sourabaya New No. 1	85.00	85.00	85.00	87.24	19.13-21.02
Bali Old ..	*	*	*	*	*
Pepper:					
Muntok White ..	150.00	139.00	143.24	139.00	15.33
Lombong White ..	*	*	*	*	*
Sibu White ..	*	*	*	*	*
New Black ..	*	*	*	*	*
Old ..	*	*	*	*	*
Sarawak ..	146.00	137.00	141.47	135.52	*
Siam Black ..	*	*	*	*	*
Nutmeg:					
No. 1 ..	*	*	*	*	25.19
No. 2 ..	*	*	*	*	23.66
Cloves:					
Indian ..	44.00	41.00	42.13	41.00	*
Sumatra ..	47.00	44.00	45.88	47.00	*
Gambier:					
Rounds No. 1 ..	125.00	105.00	120.00	125.00	13.65
No. 2 ..	110.00	95.00	106.25	110.00	*
Cake ..	*	*	*	*	*
Sago Flour:					
Lingga ..	20.00	18.50	19.28	17.21	*
Local No. 1 ..	*	*	*	*	*
No. 2 ..	*	*	*	*	*
Tapioca Flour:					
Malayan No. 1 ..	29.00	29.00	29.00	29.00	*
No. 2 ..	26.00	26.00	26.00	26.00	*
Java ..	*	*	*	*	*

* Not quoted.

MALAYAN UNION PRODUCTION OF PALM OIL AND KERNELS.

(In long tons as declared by Estates)

Month 1947	Palm Oil	Palm Kernels
January	2,238.2	292.3
February	2,316.9	337.1
March	2,585.8	386.2
April	2,410.2	380.2
May	2,377.7	359.9
June	2,451.2	336.1
July	3,479.4	452.6
August	3,558.5	551.0
September	3,887.3	583.1
October	4,465.0	635.9
November	4,483.9	658.4
Total ..	34,254.1	4,972.8
Total May-December, 1946 ..	11,756.4	931.6 (Aug.-Dec.)
Total for the year 1940 ..	57,972.1	9,611.2

Stocks on estates as at 30th November, 1947, were: palm oil 2,598 tons, palm kernels 483 tons.

In November 33 estates (planted acreage 70,828.4 acres) were in production out of a total of 46 oil palm estates (planted acreage 77,981.4 acres).

MALAYAN AGRICULTURAL EXPORTS, JULY-SEPTEMBER, 1947.

Product	Net Exports in Tons.		
	Year 1940	Jan.-Sept. 1947	July, August and September, 1947
Arecanuts	43,915	7,435	3,976
Coconuts fresh†‡ ..	131,469†	56,833†	29,917†
Coconut oil‡	69,446	29,894	10,624
Copra‡	9,904*	34,106*	13,285*
Copra cake	1,215*	4,353*	1,643*
Gambier, all kinds ..	821	774	205
Palm kernels	9,219	3,443	1,487
Palm Oil	56,091	31,778	10,089
Pineapples, canned ..	40,243	1,841	1,293
Rubber¶	547,202¶§	467,165¶	156,306¶
Sago,—flour	2,525	3,204	3,334
„ —pearl	4,848	5,595	1,791
„ —raw	4,816*	5,904*	1,766*
Tapioca,—flake ..	762	33	9
„ —flour ..	2,649*	5,828	784
„ —pearl ..	17,004	5,469	2,064
Derris	1,258	193	30*
‡Copra equivalent ..	105,575	15,608	4,604

† hundreds in number. * net imports. ¶ production.
§ Malayan Union and Singapore.

MALAYAN UNION PADI STATISTICS.

Area of Land Planted and Yields of Padi Season 1946—1947.

STATE	Wet			Dry			Total Wet and Dry Padi	
	Acres	Gantangs	Average Yield (Gantangs per Acre)	Acres	Gantangs	Average Yield (Gantangs per Acre)	Acres	Gantangs
Perlis ..	36,640	10,320,000	281	60	6,200	103	36,700	10,326,200
Kedah ..	236,820	61,820,000	261	4,255	373,500	88	241,075	62,193,500
Kelantan* ..	133,730	29,636,013	222	29,893	3,587,415	120	163,623	33,223,428
Trengganu ..	34,876	5,635,617	161	18,182	2,479,480	136	53,058	8,115,097
Penang & P.Wellesley ..	37,736	8,840,280	234	590	79,275	134	38,326	8,919,555
Perak ..	106,140	17,753,000	167	15,040	1,337,000	89	121,180	19,090,000
Selangor ..	34,520	8,682,800	252	4,890	457,100	93	39,410	9,139,900
Pahang ..	39,787	7,224,800	182	4,409	380,180	86	44,196	7,604,980
N. Sembilan ..	29,612	5,807,970	196	36	1,035	29	29,648	5,809,005
Malacca ..	30,611	5,688,820	186	120	23,700	198	30,731	5,712,520
Johore ..	12,142	966,611	80	3,449	170,621	49	15,591	1,137,232
Total ..	732,614	162,375,911	222	80,924	8,895,506	110	813,538	171,271,417

* Amended figures.

171,271,417 gantangs of padi = 257,164 tons of rice.

(Conversion: 666 gantangs of padi equals 1 ton of rice).

COCONUT OIL AND COPRA CAKE STATISTICS.

Stocks and Production of Coconut Oil and Copra Cake for the month of November 1947, as declared by Principal Oil Mills only.

(in tons)

	Production			Stocks at end of month	
	Copra Treated	Coconut Oil Expressed	Copra Cake (Poonac) manufactured	Coconut Oil	Copra Cake
Singapore ..	7,183	4,013	2,706	2,930	62
Malayan Union ..					
Perak ..	2,258	1,004	1,032	127	83
Johore ..	1,370	637	568	93	13
Negri Sembilan ..	175	88	70	38	9
Selangor ..	1,429	749	570	235	23
Malacca ..	270	130	101	37	5
Penang and P. Wellesley ..	2,932	1,674	1,079	4,822	19
Kelantan ..	84	47	34	8	6
Total Malayan Union ..	8,518	4,329	3,454	5,360	158
Total Malaya ..	15,701	8,342	6,160	8,290	220

Direct Foreign Imports and Exports of Malaya (Singapore and the Malayan Union, excluding trade between these two territories) during the month of November, 1947.

(to the nearest ton)

IMPORTS				EXPORTS			
Fresh Coconuts (Numbers)	Copra	Coconut Oil	Copra Cake	Fresh Coconuts (Numbers)	Copra	Coconut Oil	Copra Cake
1,000	3,454	394	286	145,900	458	4,081	—

Notes:—(a) These tables were published by the Acting Registrar of Malayan Statistics on 30th December, 1947.

(b) Malayan Union figures are as compiled and supplied by the Acting Registrar of Statistics, Malayan Union.

(c) Details of small-holding production and stocks and dealers' stocks are not available.

MALAYAN UNION RUBBER STATISTICS.

Summary of Stocks, Production, Imports and Exports of Rubber, November, 1947.

In long tons, dry weight.

		Tons	Tons
STOCKS (31st October, 1947)			
Estates	..	21,635	
Dealers	..	52,379	
Ports, awaiting shipment	..	12,397	86,411
IMPORTS	..		4,150
PRODUCTION			
Estates	..	36,050	
Small-holdings (estimated)	..	18,419	54,469
Total	..		145,030

		Tons	Tons
EXPORTS			
Foreign	..	39,007	
Local (to Singapore)	..	25,428	64,435
LOCAL CONSUMPTION	..		320
STOCKS (30th November, 1947)			
Estates	..	24,425	
Dealers	..	45,523	
Ports, awaiting shipment	..	10,327	80,275
Total	..		145,030

Note:—The above forms part of the November rubber statistics published by the Acting Registrar of Statistics, Malayan Union, at Kuala Lumpur, on 22nd December, 1947.

MALAYAN UNION RUBBER STATISTICS.

Estates of 100 Acres and over. Production, November, 1947.

In dry tons.

STATE	PRODUCTION						STOCKS		PRODUCTION OF PRESERVED FIELD LATEX, CONCENTRATE LATEX AND REVERTEX
	European	Chinese	Indian	Others	Total	Jan./Nov. 1947	Beginning of Month	End of Month	
(1)	(2)	(3)	(4)	(5)	(6)	(7)			
Perak ..	4,936	489	283	26	5,734	53,791	3,782	4,096	4
Selangor ..	5,765	469	109	5	6,348	58,412	4,481	5,030	99
N. Sembilan ..	5,298	342	177	139	5,956	48,716	3,099	3,979	611
Pahang ..	1,178	745	112	—	2,035	20,045	1,361	1,394	—
Malacca ..	1,403	437	116	—	1,956	17,992	1,185	1,456	72
Penang & P. Wellesley	384	91	4	—	479	4,488	398	432	—
Johore ..	6,050	1,281	299	587	8,217	75,930	4,269	4,644	1,847
Kedah ..	4,028	527	156	33	4,744	41,956	2,565	2,910	767
Perlis ..	—	2	24	—	26	256	20	23	—
Kelantan ..	391	26	—	18	435	4,998	371	386	—
Trengganu ..	76	41	—	3	120	1,645	104	75	—
Total ..	29,509	4,450	1,280	811	36,050	328,229	21,635	24,425	3,400

Notes:—1. Figures for production of prepared latex for export, are included in the month's production figures, columns 2 to 6.

2. Production by estates of less than 100 acres for November, 1947, was estimated to be 18,419 tons. Total estimated smallholding production January to November, 1947, 258,327 tons.

3. Total latex production 1946, 5,223 tons. Latex production October, 1947, field latex 611 tons, centrifuge 1,923 tons, revertex 140 tons.

4. Stocks on estates of less than 100 acres are not ascertained.

5. The above forms part of the November rubber statistics published by the Acting Registrar of Statistics, Malayan Union, at Kuala Lumpur, on 22nd December, 1947.

MALAYAN UNION RUBBER STATISTICS.

Acreages of Tappable Rubber Actually Tapped and not Tapped on Estates of 100 Acres and over for the Month ending 30th November, 1947.

STATE	Estimated Acreages of Tappable Rubber (9) + (11)	Acreages of tappable Rubber not tapped: On estates which have entirely ceased tapping		On estates which have partly ceased tapping (a)		Area of tappable rubber never been tapped (b)		Total Area not tapped (3) + (5) (c)		Total Area tapped during the month (c)		Area of tappable rubber rested under rotational systems (c)	
		Acreage	% of (3) to (2)	Acreage	% of (5) to (2)	Acreage	% of (7) to (2)	Acreage	% of (9) to (2)	Acreage	% of (11) to (2)	Acreage	% of (13) to (2)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Perak ..	272,897	1,142	.4	31,023	11.4	8,658	3.2	32,165	11.8	240,732	88.2	23,558	8.6
Selangor ..	322,832	2,019	.6	33,601	10.4	9,526	2.9	35,620	11.0	287,212	89.0	17,383	5.4
N. Sembilan ..	256,936	3,058	1.2	41,532	16.2	12,442	4.8	44,590	17.4	212,346	82.6	10,018	3.9
Pahang ..	95,360	647	.7	18,810	19.7	9,537	10.0	19,457	20.4	75,903	79.6	4,668	4.9
Penang & P. Wellesley ...	28,025	411	1.5	3,125	11.1	544	1.9	3,536	12.6	24,489	87.4	4,517	16.1
Malacca ..	119,750	517	.4	13,368	11.2	4,131	3.4	13,885	11.6	105,865	88.4	10,320	8.6
Johore (d) ..	467,200	9,349	2.0	81,708	17.5	27,923	6.0	91,057	19.5	376,143	80.5	30,936	6.6
Kedah ..	196,809	492	.3	20,551	10.4	8,482	4.3	21,043	10.7	175,766	89.3	26,871	13.7
Kelantan ..	30,385	485	1.6	9,744	32.1	1,050	3.5	10,229	33.7	20,156	66.3	744	2.4
Trengganu ..	15,094	510	3.4	5,186	34.3	1,629	10.8	5,696	37.7	9,398	62.3	589	3.9
Perlis ..	1,839	—	—	484	26.3	132	7.2	484	26.3	1,355	73.7	150	8.2
Total ..	1,807,127	18,630	1.0	259,132	14.4	84,054	4.6	277,762	15.4	1,529,365	84.6	129,754	7.2

Notes:—(a) Area out-of-tapping on estates which have partly ceased tapping refers to areas definitely being rested and excludes area on any tapping round.

(b) The acreage shown in column (7) is included in columns (3) and (5).

(c) Acres of tappable rubber rested under rotational systems are not considered as out-of-tapping and therefore columns (11) and (12) include columns (13) and (14) respectively.

(d) Registered estates only.

(e) This table was published by the Acting Registrar of Statistics, Malayan Union, on 23rd December, 1947.

METEOROLOGICAL SUMMARY, MALAYA, AUGUST, 1947.

Locality.	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes						Total		Most in a day.	Number of days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Mean of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunder-storm	Fog morning obs.	Gale force 8 or more			
										ins.	m.m.	ins.								
Ipoh, Perak ..	92.4	73.7	83.1	97	71	84	77			9.30	236.4	2.76	16	10	3					
Port Swettenham, Selangor	89.3	73.0	81.1	92	69	83	75	84.3	84.8	6.51	165.4	1.48	15	12	1					
Sitiawan, Perak ..	88.5	73.5	81.0	91	70	82	78			11.21	284.7	4.62	15	12	4	1				
Kuala Lipis, Pahang ..	89.5	72.6	81.1	93	70	79	75	83.2	85.3	7.70	195.6	3.12	13	11	5	25				
Kuantan, Pahang ..	89.9	72.7	81.3	95	71	80	75			5.19	150.1	1.50	19	14	4	3				
Bayan Lepas, Penang ..	87.4	74.9	81.1	90	72	81	78			16.44	417.6	3.04	18	17	11					
Malacca ..	85.6	74.4	80.0	88	69	81	79			7.79	197.9	3.07	18	15						
Mersing, Johore ..	87.3	72.7	80.0	91	71	78	76			8.14	206.8	2.08	18	13	5					
Alor Star, Kedah ..	89.4	74.8	81.9	92	71	82	77			5.39	136.9	2.18	14	11	3	1				
K. Trengganu, Trengganu	89.6	73.0	81.3	92	71	82	76			3.91	99.3	1.43	14	9	5	1				
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. ..	73.9	62.9	68.4	78	60	67	65	71.7		5.32	135.1	1.29	20	16	1	5				
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	73.4	58.2	65.8	78	51	67	63	70.0		8.68	220.5	1.96	20	18		3				

Compiled from Returns supplied by the Meteorological Branch, Malaya.

METEOROLOGICAL SUMMARY, MALAYA, SEPTEMBER, 1947.

Locality.	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes						Total		Most in a day.	Number of days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Mean of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunder-storm	Fog morning obs.	Gale force 8 or more			
										ins.	m.m.	ins.								
Ipoh, Perak ..	90.7	72.9	81.8	95	69	82	77			6.40	162.6	0.94	20	18	7					
Port Swettenham, Selangor	89.2	73.0	81.1	92	71	84	75	85.0	85.0	4.94	125.5	1.19	15	11	1					
Sitiawan, Perak ..	88.3	73.2	80.7	91	70	82	75			3.53	89.7	0.78	15	11						
Kuala Lipis, Pahang ..	89.5	72.3	80.9	93	70	81	75	83.5	85.4	6.08	154.4	1.74	13	12	2	24				
Kuantan, Pahang ..	89.1	72.3	80.7	94	70	80	74			8.59	218.2	2.82	17	15	5	6				
Bayan Lepas, Penang ..	86.9	74.7	80.8	91	72	77	78			20.59	523.0	9.76	16	12	2		2			
Malacca ..	85.6	74.0	79.8	88	72	81	77			13.80	350.5	3.55	23	14			2			
Mersing, Johore ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
Alor Star, Kedah ..	88.2	73.4	80.8	91	71	79	76			6.56	166.6	1.86	15	13	1					
K. Trengganu, Trengganu	89.0	73.1	81.1	93	69	83	76			3.60	91.4	1.02	14	12	5					
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. ..	73.9	62.4	68.1	77	59	70	65	71.6		8.05	204.5	1.14	15	15	1	1				
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	73.0	57.5	55.2	76	53	67	62	69.8		8.09	205.5	1.98	24	21	3	8				

Compiled from Returns supplied by the Meteorological Branch, Malaya.

METEOROLOGICAL SUMMARY, MALAYA, OCTOBER, 1947.

Locality.	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes						Total		Most in a day.	Number of days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Mean of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunder-storm	Fog morning obs.	Gale force 8 or more			
										ins.	m.m.	ins.								
Ipoh, Perak ..	89.7	72.3	81.0	92	69	86	75			7.32	185.9	1.38	23	21	3					
Port Swettenham, Selangor	89.2	73.3	81.3	92	70	85	75	84.9	85.1	5.34	135.6	1.81	16	12	1					
Sitiawan, Perak ..	87.8	73.1	80.5	90	69	81	76			7.59	192.8	1.81	17	15	3					
Kuala Lipis, Pahang ..	89.3	72.3	80.8	92	70	84	75	82.7	85.0	6.32	160.5	1.45	17	14	1	21				
Kuantan, Pahang ..	88.8	72.5	80.7	92	70	81	75			6.15	156.2	1.83	14	11	4	11				
Bayan Lepas, Penang ..	86.1	74.9	80.5	91	72	76	78			17.45	443.2	3.68	18	16	1	10				
Malacca ..	85.9	74.3	80.1	88	72	83	78			6.41	162.5	1.35	20	18			4			
Mersing, Johore ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
Alor Star, Kedah ..	87.3	73.7	80.5	93	71	77	76			11.88	301.8	2.31	22	18	3	1				
K. Trengganu, Trengganu	86.2	72.9	79.5	90	71	77	75			12.39	314.7	2.59	22	18	4	1				
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. ..	73.7	62.9	68.4	77	61	67	65	71.3		7.46	189.5	2.10	18	15	4	1				
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	70.8	56.3	63.5	77	53	69	62	69.5		11.79	299.5	2.73	23	20		3				

Compiled from Returns supplied by the Meteorological Branch, Malaya.